NORMAN A. JOHNSON
Editor

CHARLES A. WHITEHEAD
Managing Editor

MYRON D. REESER
Business Manager

HERBERT A. STAUDERMAN
Advertising Manager

JAMES A. DOYLE
Promotion Manager

FRANK R. MURPHY
Production Manager

LILLIAN M. THOMPSON
Circulation Manager

OFFICIAL PUBLICATION OF THE PROCEEDINGS AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS

American Dyestuff Reporter was founded in 1917 and the Textile Colorist and Converter (formerly Textile Colorist) was incorporated with it in January, 1949. Published every other Monday by the HOWES PUBLISHING COMPANY, INC., 44 E. 23rd Street, New York 10, N. Y. C. R. Howes, President; Ernest J. Finan, Executive Vice-President; Norman A. Johnson, Vice-President & Treasurer; Myron D. Reeser, Vice-President; C. Essenbreis, Secretary.

Telephone SPring 7-9364

AMERICAN
DYESTUFF REPORTER

Devoted to Textile Chemistry
BLEACHING • DYEING • PRINTING • FINISHING

Contents

VOLUME 43 FEBRUARY 15, 1954 NUMBER 4

• ***Special Articles***

A Qualitative Analysis of the Synthetic Fibers 93
Marjorie Lundegard and Elizabeth D Roseberry

Substratum Form in Wool Dyeing..... 98
Anantha K Setty

Historical Notes on the Wet Processing Industry. II—A Look at the Early Dyers' Guilds.. 119
Sidney M Edelstein

• ***Departments***

Abstracts 97
Book Reviews 120
News 121

• ***Proceedings of the American Association of Textile Chemists and Colorists***

Calendar P102
Employment Register P102
New York Section:—
New Textile Fibers with the Structural Elements of Natural Cellulosic Fibers.....P103
Jack Compton

AATCC Committee on Stream Pollution:—
Case Histories of Stream Pollution.....P112
I—Textile Effluent and a Sewage Plant..P112
John B Dick
II—History of Operations of Textile-Sewage Plants in Connecticut.....P112
Willis J Snow
III—Plant for Textile Sewage.....P114
A N Henschel

Minutes of January 15, 1954 Meeting—Perkin Centennial General Committee.....P116
Reports from Local Sections.....P117
Notice to Authors of Papers.....P118

Copyright, 1954, Howes Publishing Co, Inc

Contents of previous issues can be found by consulting the Industrial Arts Index and the Engineering Index, Inc. at your library

Light-fast · Water-fast · Brilliant

perfect for playclothes

ORANGE RF SALT

Coupled with selected Naphthols, National Orange RF Salt produces shades of outstanding light-fastness and brilliance for colors of this type. It also has excellent fastness to washing and soda boil, and is especially recommended for dyeing or printing cotton or viscose children's wear, play and sports clothes as well as washable upholstery and drapery fabrics.

The nearest National Aniline office will be pleased to send you a data sheet showing a range of dyeings and giving complete fastness properties of National Orange RF Salt coupled with 13 selected Naphthols.

And for prompt service on any dyestuff need, always phone National Aniline *first*.

NATIONAL ANILINE DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 RECTOR STREET, NEW YORK 6, N.Y. · BOwling Green 9-2240

Boston 14, Mass., 150 Causeway St.	CApitol 7-0490	Richmond 19, Va., 8 North Fifth St.	Richmond 2-1930
Providence 3, R.I., 15 Westminster St.	DExter 1-3008	Columbus, Ga., Columbus Interstate Bldg.	Columbus 3-1029
Philadelphia 6, Pa., 200-204 S. Front St.	LOmbard 3-6382	Greensboro, N.C., Jefferson Standard Bldg.	GReensboro 2-2518
San Francisco 5, Cal., 517 Howard St.	SUtter 1-7507	Chattanooga 2, Tenn., James Building	CHattanooga 6-6347
Portland 9, Ore., 730 West Burnside St.	Beacon 1853	Atlanta, Ga., 1216 Spring St., N. W.	Elgin 0308
Chicago 54, Ill., The Merchandise Mart	SUperior 7-3387	New Orleans 12, La., Carondelet Building	Raymond 7228
Charlotte 1, N.C., 201-203 West First St.	CHarlotte 3-9221	Toronto 2, Canada, 137-143 Wellington St. W.	Empire 4-6495

AMERICAN

DYESTUFF REPORTER

VOLUME 43 FEBRUARY 15, 1954 NUMBER 4

A QUALITATIVE ANALYSIS OF THE SYNTHETIC FIBERS*

MARJORIE LUNDEGARD and ELIZABETH D ROSEBERRY

The purpose of this study was to establish easy, accurate, and reproducible procedures for identification of the synthetic fibers nylon, Dacron, Orlon, Acrilan, X-51, Dynel, Saran, and polyethylene.

The following tests were used in identifying these fibers:

1) the test for detecting chlorine
2) the flame test
3) their reaction to chemical compounds
4) the microscopic test
5) the use of an identification dye.

The results of these tests are presented and summarized in simplified tables, showing the effect of heat and concentration of the chemical reagents, the longitudinal and cross-sectional appearances of the fibers, the colors produced by the identification dye Texchrome, and the odors, residue, and behavior of the fibers when subjected to a flame.

INTRODUCTION

FIFTEEN years ago the identification of the textile fibers was a relatively simple matter. A match and a microscope were all the equipment necessary for most purposes. If chemical reagents were needed, acetone or 5 per cent sodium hydroxide were most commonly used.

Since then, with the development of the synthetic fibers, the problem of identification has grown more complex. A match, a microscope, and a simple reagent no longer give the answer. These fibers respond similarly when subjected to a flame. They are, for the most part, relatively inert chemically. They look very much alike in their longitudinal appearance when observed under the microscope, since they have no identifying characteristics, such as scales, nodes, etc. Only their cross-sectional appearances can be an aid in the identification of these fibers.

The purpose of this study was to develop an easy, accurate, and reproducible procedure to use for identifying the synthetic fibers. The synthetic fibers used were nylon, Dacron, Orlon, Acrilan, X-51, Dynel, Saran, and polyethylene. Of these, the Dynel and X-51 were staple fibers, and the others, filament fibers. Samples of each were obtained from the companies which produce them.

PROCEDURE

This study was divided into three parts. Part I was concerned with the solubility of the synthetic fibers in chemical reagents which were used in various concentrations and at different temperatures; part II dealt with the microscopy of the fibers; and part III dealt with miscellaneous tests which might be useful in the identification of the fibers.

In Part I, the various fibers were subjected to chemical reagents under standardized conditions in which the temperature was varied. The reactions were observed at room temperature, over a steam bath, and over a direct flame. First, a 30-ml portion of the reagent was poured into an evaporating dish. Then, a three-inch sample from each of the yarns was put in the evaporating dish so that about half of the sample was submerged in the solution. The samples were left in the reagent for ten minutes. The results were recorded, noting whether the fiber was soluble, partially soluble, insoluble, or disintegrated.

In Part II, longitudinal and cross sections of the fibers were mounted on slides in Permount, and then examined under a Bausch and Lomb microscope with a magnification of 430x, using artificial light as the source of illumination.

In Part III, other methods of identification were used in an effort to obtain good positive tests for each fiber. The following tests were used:

a) *Use of an identification dye*

Texchrome, produced by the Fisher Scientific Co, was used as the identification dye. A yarn from each sample was dyed with a drop of the dye, and after two minutes, was thoroughly rinsed. The color was noted.

b) *Use of the flame test*

A yarn from each sample was advanced slowly towards the flame. The ignition of the sample, the odor, and the residue were observed.

c) *The Lieberman-Storch test*

This test was used to detect the presence of the following groups by differences in color: vinyl acetate, vinyl acrylate, vinyl chloride, and vinylidene chloride. The sample was placed on a watch glass and covered with acetic anhydride. One drop of concentrated sulfuric acid was added to the liquid. The color change of the liquid and fiber was noted over a thirty-minute period.

d) *A test to detect chlorine*

A small sample of the yarn was put in a clean pyrex test tube which was held over a flame. The fumes from the yarn were caught in another test tube. These fumes were dissolved in 5 ml of distilled water. A few drops of silver nitrate were added to this solution. If chlorine was present, a white precipitate of silver chloride was formed which could be dissolved in ammonia.

In dealing with the reactivity of the fibers in the chemical compounds, the following general aspects of solubility were kept in mind: 1) that similar or like chemical and structural features favor solubility; 2) that similar internal pressures favor solubility; 3) that similar polarity between solute and solvent favor solubility *(4)*.

The reactions of the synthetic fibers used in this study to various organic chemical compounds at room temperature are shown in Table I. Table II shows the results using the same chemicals over a steam bath. The reactions of these fibers to various inorganic compounds at room temperature and also on a steam bath are shown in Tables III and IV. Table V shows the results obtained with the latter compounds when a direct flame was used as the source of heat.

* This work was done as a partial fulfillment of the requirement for M S degree at Purdue University by Mrs Lundegard under the direction of Professor Elizabeth D Roseberry.

FINDINGS

NYLON———Nylon, a polyamide, has many amide linkages which are easily destroyed by concentrated mineral acids. It was found to be affected by the phenolic compounds, phenol and m-cresol, at room temperature, and the organic acid, glacial acetic, if heated. Nylon was found to be soluble in 50 per cent solutions of zinc chloride and calcium chloride when heated on the steam bath for ten minutes, and also a 50 per cent solution of lithium bromide when heated over the direct flame. Nylon, however, was not affected by the halogenated hydrocarbons, alcohols, ketones, ethers, esters, and alkalies.

DACRON———Usually esters are readily hydrolyzed, but this is not true of Dacron, which is a polyester. At room temperature, it is not visibly affected by weak or strong alkalies. However, in our work, it was found that Dacron was destroyed in boiling strong alkalies, and was attacked by boiling weak alkalies. It was found that 95 per cent sulfuric acid would disintegrate Dacron, but that 70 per cent sulfuric acid would give no visible evidence of disintegrating it. It is also attacked by 37 per cent hydrochloric acid. It has been claimed that boiling ethylene diamine would dissolve it *(2)*, but the Dacron used in this study did not dissolve when subjected to this compound. At room temperature, Dacron was found to be insoluble in 80 per cent phenol, but when this solution was heated, the fiber was dissolved. Meta-cresol dissolves Dacron only when heated.

THE ACRYLICS ——— Since the "acrylic" fibers, Orlon, Acrilan, and X-51, resemble each other chemically, they will be discussed together. Acrilan and X-51 are copolymers having different vinyl derivatives as their minor components, while Orlon is a one hundred per cent acrylonitrile fiber. Fibers containing as much as 85 per cent of acrylonitrile will react similarly, no matter what their minor constituents. Orlon, Acrilan, and X-51 are not affected by such organic solvents as ketones, alcohols, esters, ethers, aromatic hydrocarbons, and halogenated hydrocarbons. Previous work showed that Orlon was soluble in lithium bromide, dimethyl formamide, and p-nitro phenol *(1)*. In our study, however, it was found that Orlon was not soluble in any of these three compounds at room temperature, but was soluble in dimethyl formamide when heated on a steam bath. Acrilan and X-51 were also soluble in this reagent when heated on a steam bath. Only X-51 of the acrylic fibers was found to be soluble in 70 per cent p-nitro phenol when heated on a steam bath, while Acrilan was found to be partially soluble, and Orlon insoluble. All three were found to be soluble in a 50 per cent solution of lithium bromide when it was heated over a direct flame. It was found that these three fibers were soluble in calcium thiocyanate at room temperature, and in 70 per cent ammonium thiocyanate and 70 per cent potassium thiocyanate if heated on the steam bath. All were destroyed in cold 95 per cent sulfuric acid, but unaffected in cold 60 or 70 per cent sulfuric acid. X-51 was the only one which disintegrated in the 60 per cent solution when it was heated on the steam bath, while both X-51 and Acrilan were destroyed in the 70 per cent solution thus heated. Concentrated hydrochloric acid did not affect the fibers. Only X-51 was found to turn orange in color when subjected to an alkali at room temperature. However, Orlon and Acrilan turned orange in color when they were heated in an alkali over the direct flame. Since Acrilan and X-51 are known to be copolymers, various reagents were used which were specific for the constituents that are thought to be the minor components in the fibers. However, because here is such a small percentage of these constituents present, the chemical compounds chosen had no effect.

DYNEL ——— Dynel, a copolymer which has as its minor constituent acrylonitrile and as its major constituent vinyl

TABLE I

REACTIONS OF THE SYNTHETIC FIBERS TO VARIOUS ORGANIC CHEMICALS AT ROOM TEMPERATURE*

Chemical Compounds	*Nylon*	*Dacron*	*Orlon*	*Acrilan*	*X-51*	*Dynel*	*Saran*	*Polyethylene*
methanol	I	I	I	I	I	I	I	I
ethanol 95%	I	I	I	I	I	I	I	I
Cellosolve	I	I	I	I	I	I	I	I
1-4 dioxane	I	I	I	I	I	I	I	I
methyl acetate	I	I	I	I	I	I	I	I
amyl acetate	I	I	I	I	I	I	I	I
acetone	I	I	I	I	I	S	I	I
methyl ethyl ketone	I	I	I	I	I	I	I	I
cyclohexanone	I	I	I	I	I	PS	PS	I
glacial acetic acid	I	I	I	I	I	I	I	I
maleic anhydride	I	I	I	I	I	I	I	I
xylene	I	I	I	I	I	I	I	I
benzene	I	I	I	I	I	I	I	I
toluene	I	I	I	I	I	I	I	I
monochlorobenzene	I	I	I	I	I	I	I	I
carbon tetrachloride	I	I	I	I	I	I	I	I
ethylene dichloride	I	I	I	I	I	I	I	I
ethylene diamine	I	I	I	I	I	I	I	I
dimethyl formamide	I	I	I	I	I	S	I	I
m-cresol	S	I	I	I	I	I	I	I
phenol 80%	S	I	I	I	I	I	I	I
p-nitro phenol 70%	I	I	I	I	I	I	I	I

* Time of treatment: 10 minutes
I = insoluble
PS = partially soluble
S = soluble

TABLE II

REACTIONS OF THE SYNTHETIC FIBERS TO VARIOUS ORGANIC CHEMICALS WHEN HEATED ON A STEAM BATH*

Chemical Compounds	*Nylon*	*Dacron*	*Orlon*	*Acrilan*	*X-51*	*Dynel*	*Saran*	*Polyethylene*
methanol	I	I	I	I	I	I	I	I
ethanol 95%	I	I	I	I	I	I	I	I
Cellosolve	I	I	I	I	I	I	I	I
1-4 dioxane	I	I	I	I	I	PS	S	I
methyl acetate	I	I	I	I	I	I	I	I
amyl acetate	I	I	I	I	I	I	I	I
acetone	I	I	I	I	I	S	I	I
methyl ethyl ketone	I	I	I	I	I	S	I	I
cyclohexanone	I	I	I	I	I	S	S	I
glacial acetic acid	S	I	I	I	I	I	I	I
maleic anhydride	S	I	I	I	I	I	I	I
xylene	I	I	I	I	I	I	I	S
benzene	I	I	I	I	I	I	I	S
toluene	I	I	I	I	I	I	I	S
monochlorobenzene	I	I	I	I	I	I	S	S
carbon tetrachloride	I	I	I	I	I	I	I	S
ethylene dichloride	I	I	I	I	I	PS	PS	I
ethylene diamine	I	I	I	I	I	I	turns brown	I
dimethyl formamide	I	I	S	S	S	S	S	I
m-cresol	S	S	I	I	I	PS	I	I
phenol 80%	S	S	I	I	PS	S	I	I
p-nitro phenol 70%	S	I	I	PS	S	PS	I	I

* Time of treatment: 10 minutes
I = insoluble
PS = partially soluble
S = soluble

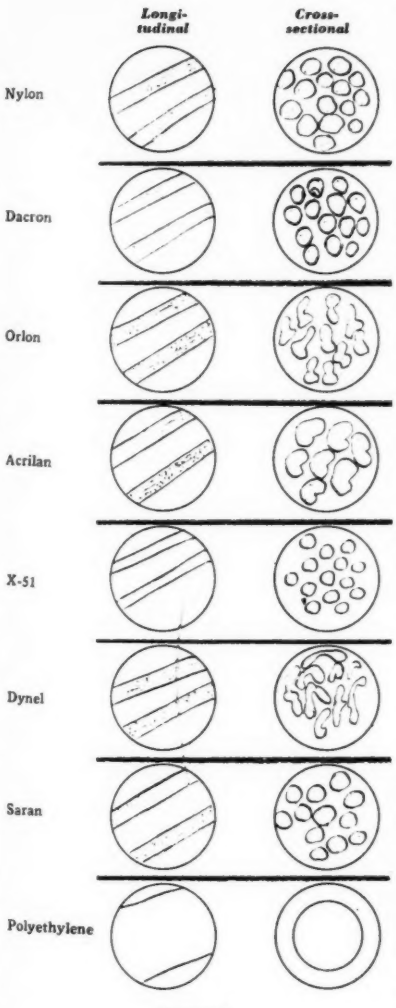


Figure 1
Microscopic Test

chloride, reacted differently in some chemicals in which Orlon, Acrilan, and X-51 were soluble. It was not soluble in calcium, potassium, or ammonium thiocyanate. It was affected slightly by 95 per cent sulfuric acid and concentrated nitric acid, but found to be inert in concentrated hydrochloric acid. Dilute or concentrated alkalies, inorganic salts, organic acids, and aromatic hydrocarbons had no effect on Dynel. It was soluble in ketones and pyridine.

SARAN ——— Saran, a copolymer of vinyl chloride and vinylidene chloride, was not affected by the alcohols, mineral acids at all concentrations, alkalies, organic acids, and inorganic salts. In an article written by Kenneth Rose *(3)*, it was claimed that Saran was soluble in ammonium hydroxide. However, in our experiments it showed no visible effects when subjected to this compound, either hot or cold. Temperature was an impor-

TABLE III

REACTIONS OF THE SYNTHETIC FIBERS TO VARIOUS INORGANIC COMPOUNDS AT ROOM TEMPERATURE*

Inorganic Compounds	*Nylon*	*Dacron*	*Orlon*	*Acrilan*	*X-51*	*Dynel*	*Saran*	*Polyethylene*
95% sulfuric acid	D	D	D	D	D	A	I	I
70% sulfuric acid	D	I	I	I	I	I	I	I
60% sulfuric acid	D	I	I	I	I	I	I	I
37% hydrochloric acid	D	I	I	I	I	I	I	I
20% hydrochloric acid	D	I	I	I	I	I	I	I
60% nitric acid	D	A	D	D	D	A	I	I
50% potassium hydroxide	I	I	I	I	turns orange	I	I	I
40% sodium hydroxide	I	I	I	I	turns orange	I	I	I
5% sodium hydroxide	I	I	I	I	turns orange	I	I	I
29% ammonium hydroxide	I	I	I	I	I	I	I	I
50% zinc chloride	I	I	I	I	I	I	I	I
50% calcium chloride	I	I	I	I	I	I	I	I
50% lithium bromide	I	I	I	I	I	I	I	I
70% ammonium thiocyanate	I	I	I	I	I	I	I	I
70% potassium thiocyanate	I	I	I	I	S	I	I	I
calcium thiocyanate	I	I	S	S	S	I	I	I

* Time of treatment: 10 minutes
I = insoluble
S = soluble
A = partially disintegrates
PS = partially soluble
D = disintegrates

TABLE IV

REACTIONS OF THE SYNTHETIC FIBERS TO VARIOUS INORGANIC COMPOUNDS WHEN HEATED ON A STEAM BATH*

Inorganic Compounds	*Nylon*	*Dacron*	*Orlon*	*Acrilan*	*X-51*	*Dynel*	*Saran*	*Polyethylene*
95% sulfuric acid	D	D	D	D	D	A	I	I
70% sulfuric acid	D	I	I	D (slowly)	D	I	I	I
60% sulfuric acid	D	I	I	I	D (slowly)	I	I	I
37% hydrochloric acid	D	I	I	I	I	I	I	I
20% hydrochloric acid	D	I	I	I	I	I	I	I
60% nitric acid	D	A	D	D	D	A	I	I
50% potassium hydroxide	I	I	I	I	turns orange	I	I	I
40% sodium hydroxide	I	I	I	I	turns orange	I	I	I
5% sodium hydroxide	I	I	I	I	turns orange	I	I	I
29% ammonium hydroxide	I	I	I	I	I	I	I	I
50% zinc chloride	S	I	I	I	S	I	I	I
50% calcium chloride	S	I	I	I	I	I	I	I
50% lithium bromide	I	I	I	I	I	I	I	I
70% ammonium thiocyanate	I	I	S	S	S	PS	I	I
70% potassium thiocyanate	I	I	S	PS	S	I	I	I
calcium thiocyanate	I	I	S	S	S	I	I	I

* Time of treatment: 10 minutes
I = insoluble
S = soluble
A = partially disintegrates
PS = partially soluble
D = disintegrates

TABLE V

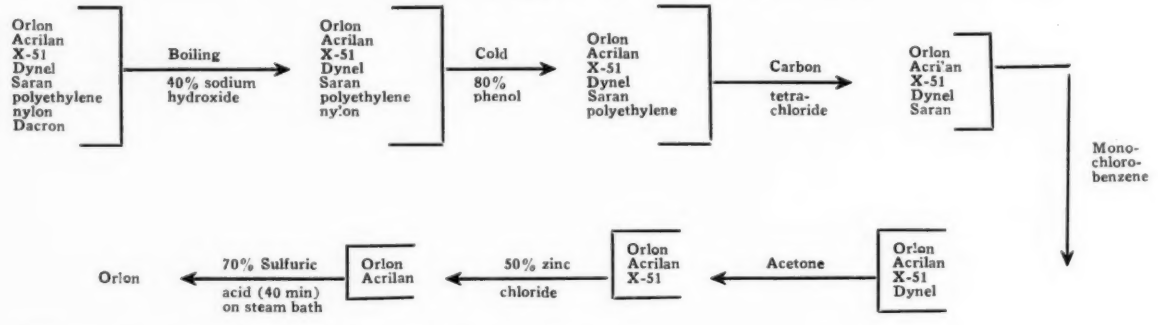
REACTIONS OF THE SYNTHETIC FIBERS TO VARIOUS CHEMICAL COMPOUNDS WHEN HEATED OVER THE DIRECT FLAME*

Reagents	*Nylon*	*Dacron*	*Orlon*	*Acrilan*	*X-51*	*Dynel*	*Saran*	*Polyethylene*
70% sulfuric acid	D	I	D	D	D	I	I	I
60% sulfuric acid	D	I	D	D	D	I	I	I
50% potassium hydroxide	I	D	turns orange	turns orange	turns orange	I	I	I
40% sodium hydroxide	I	D	turns orange	turns orange	turns orange	I	I	I
5% sodium hydroxide	I	I	turns orange	turns orange	turns orange	I	I	I
29% ammonium hydroxide	I	I	I	I	I	I	I	I
50% lithium bromide	S	I	S	S	S	S	A	I (shrinks)

* Time of treatment: 10 minutes
I = insoluble
S = soluble
A = partially disintegrates
PS = partially soluble
D = disintegrates

TABLE VI

FLOW SHEET SHOWING CHEMICAL MEANS FOR SEPARATION AND IDENTIFICATION OF THE SYNTHETIC FIBERS*



* Time of treatment is 10 minutes heated on a steam bath unless stated otherwise.

tant factor in the effects of many chemicals used. Pyridine, cyclohexanone, 1-4 dioxane, monochlorobenzene, and dimethyl formamide had no visible effect on Saran at room temperature, but when these chemicals were heated on a steam bath, Saran was dissolved.

POLYETHYLENE ——— Polyethylene, a polymer of ethylene, is inert in most organic and inorganic chemicals. Halogenated hydrocarbons and the aromatic hydrocarbons, when heated on a steam bath ten minutes, were the only chemicals among those used in this study which dissolved this fiber.

DISCUSSION

As a means of using the foregoing information on the solubilities of the synthetic fibers, Table VI is presented. It is a simplified flow sheet showing how the synthetic fibers can be separated and identified by means of specific reagents which will dissolve only one of the fibers. Concentrations and temperatures are given.

With the aid of the microscope, the identity of some of the synthetic fibers can be verified. Although all the synthetic fibers have somewhat similar longitudinal appearances, the cross-sectional views are more characteristic of each fiber. The cross-sectional views of Dacron, nylon Saran, polyethylene, and X-51 are round. It is possible that Orlon and Acrilan could be confused as Orlon has a dog-bone shape and Acrilan has a shape like a kidney bean. Dynel has the distinctive cross-sectional appearance of a twisted ribbon. (See Figure 1).

Oftimes identification stains help in the determination of a fiber, but obviously white fibers are necessary for this type of test. In this study, Texchrome was used as the colorant for the fibers. Nylon was the only fiber which gave a truly dis-

TABLE VII

SUMMARY OF TESTS FOR THE IDENTIFICATION OF SYNTHETIC FIBERS

	Flame Test		*Chemical Tests**								
Fibers	*Residue*	*Miscellaneous properties*	*Calcium thio-cyanate*	*Ace-tone*	*Carbon tetra-chloride*	*Cyclo-hex-anone*	*Glacial acetic acid*	*80% phenol*	*50% zinc chloride*	*70% sulfuric acid*	*Identification stain (Texchrome)*
nylon	white noncrushable bead	does not support flame amide odor	I	I	I	I	S	S	S	D	lime yellow
Dacron	white noncrushable bead	does not support flame aromatic odor	I	I	I	I	I	S	I	I	lavender
Orlon	black noncrushable bead	supports flame acrid odor	S	I	I	I	I	I	I	I	pale blue
Acrilan	black noncrushable bead	supports flame acrid odor	S	I	I	I	I	I	I	D (slowly)	pale blue
X-51	black noncrushable bead	supports flame acrid odor	S	I	I	I	I	PS	S	D	dark grey blue
Dynel	black moderately crushable bead	does not support flame acrid odor	I	S	I	S	I	S	I	I	grey-green blue
Saran	black moderately crushable bead	does not support flame chlorine odor	I	I	I	S	I	I	I	I	no color
polyethylene	waxy bead	supports flame hot paraffin odor	I	I	S	I	I	I	I	I	no color

* Heat ten minutes on steam bath.
I = insoluble PS = partially soluble
S = soluble D = disintegrates

tinctive color. The color produced on X-51 was a darker shade of blue than the color produced on the other acrylic fibers. Saran and polyethylene did not show any color with this stain. Although the colors obtained were not too specific, this staining test might be used as an additional confirmatory test along with the solubility and microscopic tests.

Since Acrilan is thought to contain vinyl acetate as its minor component, and X-51 is said to contain methyl methacrylate, the Lieberman-Storch test was used to detect the presence of these groups. However, no color change was observed on the fibers.

The results obtained from the flame test showed that the identity of the fibers could not be ascertained with this test. The odors, although difficult to describe, are characteristic for many of the fibers. Nylon has an amide odor; Dacron, an aromatic odor; Orlon, Acrilan, X-51, and dynel, an acrid odor; Saran, a chlorine odor; and polyethylene, a paraffin odor. Dacron, nylon, Saran, and Dynel do not support a flame, while Orlon, Acrilan, X-51, and polyethylene will support a flame. If Saran and Dynel are ignited, they are self-extinguishing. Nylon and Dacron form white noncrushable residues; polyethylene, a waxy residue; the acrylics, a black noncrushable residue; and Saran and Dynel, a black moderately crushable residue.

The fibers containing chlorine can be identified as such by use of a specific test to detect the presence of chlorine. This would be a good preliminary test to use. If the chlorine test is positive, then the fiber is either Dynel or Saran.

All information necessary for the identification of the synthetic fibers in this study is briefly summarized in Table VII and Figure 1. When possible, the chemicals chosen should be specific for each fiber. Table VII incorporates the solubility test, an identification stain test, and the flame test. Figure 1 incorporates the microscopic test.

BIBLIOGRAPHY

(1) Anonymous, "Synthetic Fibers", *Chem Engineering*, 125 (August, 1951).

(2) General Technical Committee C, "Identification of Textile Materials", *Textile Inst* 42, S25 (1951).

(3) Rose, Kenneth, "Newer Synthetic Fibers Show Promise of Wide Use in Industry". *Materials and Methods* 34, 76 (August, 1951).

(4) Schmidt, Alois X. and Marlies, Charles A, *Principles of High Polymer Theory and Practice*, McGraw-Hill Book Co, Inc, New York (1948).

ABSTRACTS

Dynel Characteristics and Processing

J H McCormick, *Textile Bull* 79, #11, 75-8, November, 1953.

A great deal of the success of a Dynel fabric or Dynel-blend fabric depends on the finishing of the fabric. Fiber blends of Dynel with wool, cotton, rayon, and rayon and acetate are being successfully introduced. Usually Dynel is present to the extent of 25-35 per cent of the mix.

The most important single factor in finishing Dynel blends is the avoidance of tension in either the warp or filling direction. When Dynel is present, the high elasticity of the fiber will result in positive shrinkage of the fabric upon subsequent pressing or sponging, and progressive shrinkage will continue until these strains are relieved.

Thus, grey goods mills should weave to allow for the shrinkage resulting from the finishing operations; and the dyeing and finishing plant should be permitted to employ equipment such as the overfeed tenter to deliver fabrics in their normal relaxed dimensions.

In dyeing the new rayon and rayon-acetate blends containing Dynel, few changes in the dyeing techniques are necessary. Bath temperatures of 205-210° F are employed when the Dynel is to be dyed, and slow cooling precautions are exercised in cooling the dyebath to prevent wrinkles being set in the fabric. It is preferable to piece-dye on boxes. The usual temperatures employed in curing resin finishes should be used, and these high temperatures are considered an important part of the fabric-stabilization process.

Semi-decating will eliminate the necessity for a final framing operation, and will give color stability.

Wool-Dynel blends are made having Dynel contents of 25-50 per cent. Selected metallized dyes are recommended for light to medium shades. Here also semi-decating is found valuable.

Dynel loses its luster in boiling water. To restore the natural luster it must be after-treated. Loop drying at 275-300° F, as used in curing resins on rayon, will reluster the fiber. Semi-decating is also effective on blends with either wool, rayon, or acetate.

In a blend of Dynel-cellulose, the Dynel may be dissolved out with acetone, or the cellulose may be removed by the use of 70 per cent sulfuric acid. In this way the "inner structure" of either fiber in a fabric may be examined for uniformity, color, fastness, etc.—WHC

A Survey of Dyeing Above 100° C in Package Dyeing

J Annicq (Belgium), *Indian Textile J* 63, 788-9, September, 1953.

The writer, a dyer of many years' experience, claims that dyeing at over 100° C can only be justified for such fibers as Orlon and Dacron, and only for so long as better technique, better dyeing methods, and possibly more appropriate dyestuffs for these fibers are lacking, and the only way to dye them in full shades is at temperatures over 100° C.

He points out that Acrilan dyes "quite satisfactorily" below 100° C, and the other fibers offer no reason for going above this temperature. He states that there are even synthetic yarns, Kuralon or Vinylon, which cannot possibly be dyed above 100° C on cheeses, or even in loose fibers at 90° C, nor can they be successfully ironed at the usual ironing temperature. The same applies to Dynel. Saran is also sensitive to heat. Kuralon, Vinylon and Dynel cheeses deserve the name of "cheeses" because when overheated the packages soften to a slimy, impenetrable mass resembling a lump of cheese.

High-temperature dyeing of cotton is dangerous, he says, if carried out on raw cotton or yarn on account of the reducing action of the cotton impurities upon the dyestuffs. How many dyes will stand up to over 100° C is not yet widely known, not even by the dye makers themselves.

He claims that speed of dyeing does not depend on high temperature but on the amount of electrolyte, pH of the dyebath, and the temperature at which each individual dyestuff has its maximum affinity for the fiber.

He concludes with this recommendation: "For those dyers who might be tempted to go to the trouble and expense to find out for themselves the secrets which lie beyond the 100° C temperature, the writer's advice is 'don't', as they may not be any happier after it."—WHC

SUBSTRATUM FORM IN WOOL DYEING*

ANANTHA K SETTY

Graduate Student, Lowell Technological Institute

By the application of Fick's equation for diffusion in a steady state, which Speakman and Smith have shown applies in the dyeing of wool, the author has been able to demonstrate that the middle straight portion of the curve connecting proportion of total exhaustion at any time (E/E_∞) with square root of dyeing time ($\sqrt{t}$ represents the true dyeing characteristic of a dyestuff for the wool fiber, i e, the diffusion dyeing rate. The initial part of the curve represents the time required for the dye to reach the fiber; the part beyond the straight portion represents the dyeing to exhaustion that takes place after dye has reached the center of the fiber.

The important conclusion from the research is that fundamental studies of dyeing rates for dyes and fibers should be carried out with fibers rather than with yarns and fabrics because the initial dyeing period, which is determined by twist or weave, interferes with the determination of rate-of-diffusion dyeing. It is rate-of-diffusion dyeing that is not only characteristic of dyestuff and fiber but it is independent of textile construction.

INTRODUCTION

IN the field of dyeing, the most serious and basic problem confronting the research scientist is the evaluation of the effects of the variables of the dyeing process and their control. Among such variables, the effect of temperature, dyeing assistants, and agitation have been investigated to some extent. Other factors, such as the physical form of the substratum, have received little fundamental study.

In dyeing, the dye migrates between the fibers, diffuses into each fiber, and combines in some manner with the material of which the fiber is made. Penetration within the fabric and yarn is, undoubtedly, controlled[1] by their respective constructions. It is generally known also that fabrics are more difficult to penetrate than is a mass of fibers. It is conceivable, therefore, that the rate of dyeing, especially in the initial part, depends on the physical form of the substratum. The study of the physical form of the substratum as a variable has mostly been ignored, however.

This paper attempts to throw light on the qualitative and quantitative effect of the form of the substratum on rate of dyeing. The rate-of-dyeing curves for the wool fabric, yarn, and fiber, all of which are composed of the same original material, namely, wool fibers, are studied in detail.

EXPERIMENTAL

If yarns and fabrics are made from a mass of fibers selected for study, mechanical damage during processing of these fibers is inevitable. That this is true is shown by the work of D F O'Reilly and his associates *(1)*, wherein it is demonstrated that, during processing, the scales of the wool fibers are lifted. This lifting causes a higher rate of dyeing, which was used by these workers to evaluate the damage during processing. In such a case, the effect of the form of the substratum alone cannot be studied since the effect of the mechanical damage is superimposed.

A reverse technique must be employed, therefore, to obtain the fabric, yarn and fiber forms of a given material. The procedure used in this study consisted of starting with a finished fabric and peeling out yarns, then untwisting these yarns, and finally pulling out the fibers, thus avoiding mechanical damage while converting from one form to another.

The dye used was a divalent, level-dyeing acid dye, C I 1054, which is commercially sold under the name Alizarine Sapphire BN.

Two-per cent dyeings were carried out to equilibrium with a constant liquor ratio of 1:100 at a temperature of 60 ± 0.06° C (140° F) with a constant amount of agitation. At prefixed intervals during dyeing, 1-ml samples of dyebath were pipetted out and exhaustions were determined by colorimetric analysis of the samples.

For each form, three samples were dyed and their average exhaustion at each dyeing time computed. Finally the standard error was calculated. The results are reported in Table I.

TABLE I

Time mins	Exhaustion %		
	Fabric	Yarn	Fiber
1	3.5	3.5	7.7
2	5.3	10.1	14.5
4	7.9	17.0	17.7
6	10.3	19.5	23.8
8	13.5	23.8	28.8
12	18.5	33.5	35.7
20	30.7	43.2	46.8
30	40.5	53.5	57.0
40	48.7	61.0	63.7
60	60.8	70.2	73.3
80	68.2	76.3	78.2
100	73.5	79.8	80.8
120	77.7	82.0	82.8
135	...	83.0	85.0
150	80.5	84.0	85.5
160	81.7	84.3	85.7
170	82.3	84.3	85.7
180	83.7	84.3	85.7
190	83.7	84.3	85.7
Average standard error	±0.5	±0.6	±0.7

FACTORS DETERMINED

EQUILIBRIUM EXHAUSTION——Equilibrium exhaustion is reached when there is no further change in the concentration of the dyebath upon prolongation of the dyeing process. In this report equilibrium exhaustion is expressed as percentage of dye removed from the bath, based on the original concentration of the bath. Thus, this value expresses the maximum amount of dye that can be removed from the dyebath under the particular conditions of dyeing. The equilibrium exhaustion can be read from the graph in which the exhaustion is plotted against the time of dyeing (Fig 1).

TIME OF HALF DYEING——The time of half dyeing is the time required by the material to exhaust half as much dye as it will exhaust at equilibrium. Time of half dyeing is one of the conventional measures used to compare rates of dyeing. This can be readily determined from Fig 2 in which E/E_∞ is plotted against log time of dyeing.

APPARENT DIFFUSION COEFFICIENT——The apparent diffusion coefficient can be determined from an approximation of Fick's equation for diffusion in steady state, which Speakman and Smith *(2)* assert to be applicable to the dyeing of wool with acid dyes. The approximation is found to be

$$\frac{E}{E_\infty} = 2\sqrt{\frac{Dt}{\pi}} \text{ or } 2\sqrt{\frac{D}{\pi}} \cdot \sqrt{t}$$

where E is the fraction of dye diffusing across a unit area in time t, and D is the apparent diffusion coefficient. Fick's equation applies for conditions of constant concentration gradient, which is known not to exist in the dyeing of textiles. Since the concentration of dye inside the fiber is constantly increasing as dyeing proceeds, the concentration gradient must be a variable quantity which will decrease with the time of dyeing. However, Speakman and Smith (2) have found that, until such a time as the dye reaches the center of the fiber, the dyeing process will approximate diffusion into one side of an infinitely thick slab and the concentration gradient will be constant. This is known as the time of ring dyeing.

A plot of E/E_∞ against the square root of the time of dyeing shou'd yield a straight line of duration equal to the time of ring dyeing. At the end of this time the

* Research carried out under the direction of Professor John H Skinkle.

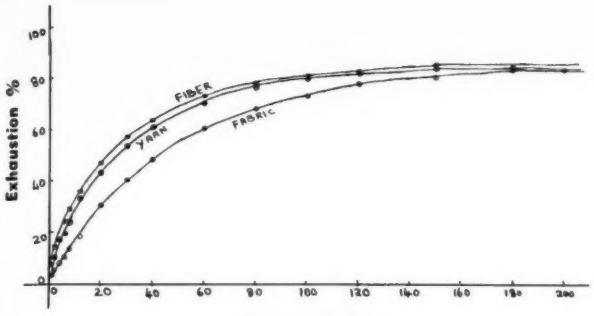


Figure 1

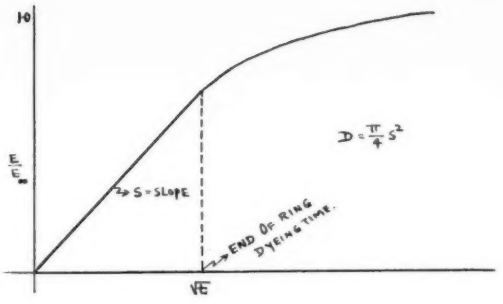


Figure 3

experimental data will deviate from the straight line since the concentration gradient is no longer constant. This is shown in Figure 3.

From the slope of this straight line portion, it is possible to determine the apparent diffusion coefficient from the equation:

$$D = \frac{\pi S^2}{4}$$

where S is the slope of the straight line and D the apparent diffusion coefficient.

AVERAGE DYEING RATE——Average dyeing rate is taken as the average rate at which all but 1% of the dye that is capable of exhaustion has been exhausted by the material. It may be determined by the equation:

$$R_{av} = \frac{E_\infty - 1}{t}$$

where t is the time at which the exhaustion is E_∞—1%. The results are reported in Table II.

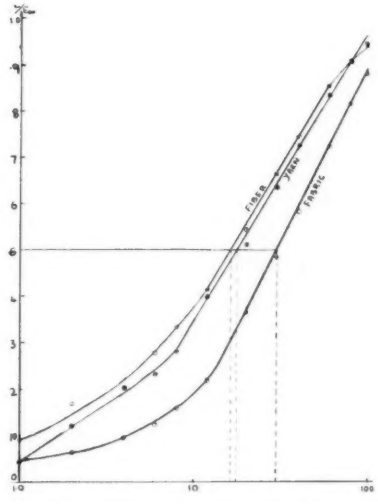


Figure 2

DISCUSSION

Table II indicates that the equilibrium exhaustions of the fabric and yarn forms are not significantly different statistically. The equilibrium exhaustions of yarn and fiber forms are just barely significantly different. The difference between the equilibrium exhaustions of the fabric and fiber is only 2%; but since the standard error at equilibrium is small, this difference is significant. For general considerations no serious error is involved in the assumption that the equilibrium exhaustion is not greatly affected by the form of the substratum. However, the time required for the yarn and fiber forms to attain these equilibrium values is different from that of the fabric form.

The E/E_∞ against the square root of time plot (Fig 4) needs careful consideration. Speakman and Smith (2) have found that, in the case of acid dyes on wool, this plot should yield a straight line passing through the origin until the dye reaches the center of the fiber. Until that time, the concentration gradient remains constant. However, it was found that the experimental data deviate from this straight line in the initial period, namely, the first few minutes. This deviation is the least for fibers and the most for fabric. In other words, the exhaustion values for the fabric are much less than the values calculated according to the ideal straight line passing through the origin. For the yarn, this deviation decreases to a considerable extent. The fiber form has the least deviation from the ideal straight line. This initial lag of dyeing could be attributed to two factors, namely: 1) Time taken by the acid to penetrate the fibers, and 2) Time taken by the dye to penetrate the structure.

It is also found that, once the effect of the structure has vanished, the plot results in a reasonably straight line until the end of the ring dyeing time. The slopes of the lines, which in turn are a measure of the respective diffusion coefficients, are practically the same. In other words, the apparent diffusion coefficients are the same for all the three forms. This is logical in view of the fact that chemically the substratum is the same despite the difference in the physical form. Because of the initial lag or deviation, which in turn is due to the form of the substratum, the straight lines when extrapolated do not pass through the origin. Instead they have an intercept on the time axis. Obviously, the intercept is the least for the fiber and the most for the fabric; and this is as it should be, because the fabric has the most compact, and the fiber, the most open form. The intercept on the time axis can thus be attributed to the structure or form of the substratum and may represent the initial penetration time. For these experiments the times are 0.04, 0.25, and 2.50 minutes for the fiber, yarn, and fabric forms respectively. This initial lag due to the form of the substratum is very significant in view of the fact that it appears to control the entire dyeing-rate curve, because, although the apparent diffusion coefficient is the same for all the three forms, the exhaustion-against-time curves are quite different for the different forms. This is reflected by the fact that the times of half-dyeing are different for the various forms despite the fact that their apparent diffusion coefficients are the same. In other words, if in the first few minutes the form of the substratum did

TABLE II

	Fabric	Yarn	Fiber
Equilibrium exhaustion, %	83.7	84.3	85.7
Time of half dyeing, mins	30.0	17.8	16.3
Apparent diffusion coef.	0.012	0.013	0.012
Average dyeing rate, %/min	0.487	0.617	0.637

not exert any influence so as to slow down the initial dyeing, then the exhaustion-against-time curves for all the three forms would have been the same. It is evident, therefore, that the rate during the initial period of dyeing greatly influences the entire dyeing process. This initial lag is found to be very much dependent on the physical form of the substratum.

The time of half dyeing for the fiber and fabric forms has a ratio of 1:1.9. This again is due to the initial lag of dyeing in the case of fabric; for, otherwise, the diffusion coefficients being the same, the times of half dyeing ought to be the same.

The average rate of dyeing, which represents the over-all rate, has a ratio of 1:1.3 for the fabric and fiber.

The conventional methods discussed so far for comparing dyeing rates give either 1) a comparison of the dyeing-rate curves as a whole over the total period of dyeing as in the case of the average rate of dyeing, or 2) a comparison at one specific time as in the case of the time of half dyeing. For a clearer understanding, it is not only desirable but also essential to find methods of comparing dyeing-rate curves in greater detail at the different stages of dyeing. Hence, a new method discussed here deserves consideration.

The E/E_∞ against the square root of time plot (Fig 5) provides us with a graph which can be conveniently analysed. This curve consists of three different and distinct portions, namely:

1) The initial portion, which deviates from the constant-rate-of-diffusion straight line.

2) The constant-rate-of-diffusion portion, or the straight-line part.

3) The portion beyond the straight line up to equilibrium.

From these three portions the three different dyeing rates, namely, the rate of initial dyeing, the rate of diffusion dyeing, and the rate of near equilibrium dyeing, are determined, as illustrated, from Figure 5.

Rate of initial dyeing =

$$\frac{A}{(\sqrt{t_A})^2} = \frac{A}{t_A}$$

Rate of diffusion dyeing =

$$\frac{1}{(\sqrt{t_B})^2 - (\sqrt{t_A})^2} = \frac{1}{t_B - t_A}$$

Rate of near-equilibrium dyeing =

$$\frac{1-B}{\sqrt{t_\infty}^2 - (\sqrt{t_B})^2} = \frac{1-B}{t_\infty - t_B}$$

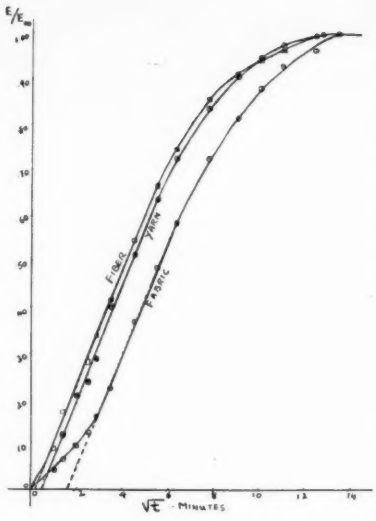


Figure 4

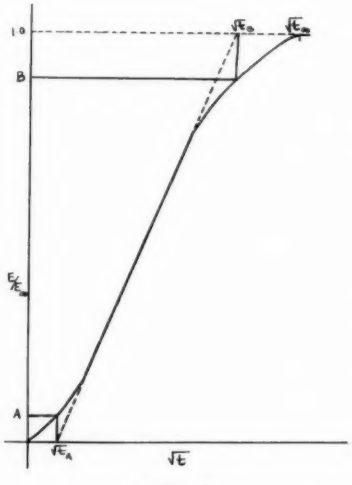


Figure 5

Thus, rates of dyeing are determined at different stages of dyeing to render comparisons clearer. For the three forms tested the results are reported in Table III.

Table III shows that the greatest difference in the rates of dyeing occurs in the initial period and that the dyeing rate remains more or less constant after the first few minutes.

Therefore, the initial dyeing rate, which is affected greatly by the form of the substratum, virtually controls the entire dyeing process.

In view of the above discussion, it is evident that any fundamental research should use fibers as the substratum, since the use of yarn and fabric causes an initial time lag which would affect any theoretical interpretation of the dyeing process. It is essential to study the initial dyeing period in greater detail. This necessitates the development of a method for accurate and sensitive measurement of exhaustions during the first few minutes and at fractions of a minute.

CONCLUSIONS

The equilibrium exhaustion of a dyebath is not appreciably affected by the physical form of the substratum.

The time of half dyeing decreases from fabric to yarn and from yarn to fiber forms, and the decrease from fabric to yarn form is greater in magnitude than that from yarn to fiber form.

The over-all rate of dyeing depends on the form of substratum, and, again, the difference between fabric and yarn forms is greater than the one between yarn and fiber forms.

The initial dyeing rate is greatly dependent on the physical form of the substratum, and this initial dyeing rate has great bearing on the dyeing during the rest of the dyeing period.

The apparent diffusion coefficient is not affected by the form of the substratum.

There exists what may be called an "initial penetration time" during which the rate of exhaustion lags behind the calculated values of an ideal case. This time is maximum for the fabric and minimum for the fiber, approaching zero.

In general, the effect of the form of the substratum is more pronounced between the fabric and yarn forms than between the yarn and fiber forms.

As fiber dyeing falls closest to the ideal case, it is deemed advisable that all fundamental research be done with fibers as the substratum to facilitate theoretical approach.

Means must be developed for accurate measurement of exhaustions during the first few minutes of dyeing as these are found to influence the rest of the dyeing.

ACKNOWLEDGMENT

The author gratefully acknowledges the invaluable guidance given by Professor John H Skinkle during this investigation.

TABLE III

	Fabric	Yarn	Fiber
Rate of initial dyeing	.028	.060	.375
Rate of diffusion dyeing	.011	.014	.015
Rate of near-equilibrium dyeing	.0015	.0014	.0013

REFERENCES

(1) O'Reilly, D F, Whitwell, J C, Steele, R O, and Wakelin, J H, *Textile Research J* 22, 441-447 (1952).

(2) Speakman, J B and Smith, S G. *J Soc Dyers Colourists* 52, 121 (1936).

Proceedings of the
American Association of Textile Chemists and Colorists

Copyright, 1954, American Association of Textile Chemists and Colorists

Editor of Proceedings: Carl Z Draves, 30 Lahey St, New Hyde Park, N Y

FEBRUARY 15, 1954

National Officers of the Association

President.....J ROBERT BONNAR, General Dyestuff Corporation, 435 Hudson St, New York 14, N Y

Vice President (Central Atlantic Region).....GEORGE L BAXTER, Bradford Dyeing Association, 40 Worth St, New York 13, N Y

Vice President (Southern Region).....SAMUEL L HAYES, Ciba Co, Inc, P O Box 1988, Charlotte 1, N C

Vice President (Western Region).....JOSEPH H JONES, Phoenix Dye Works, 1963 Southport Ave, Chicago 14, Ill

Vice President (New England Region)....GEORGE O LINBERG, Synthron, Inc, Ashton, R I

Secretary..HAROLD C CHAPIN, Lowell Technological Institute, Lowell, Mass

Treasurer.....ALBERT E SAMPSON, National Aniline Division Allied Chemical & Dye Corp, 150 Causeway St, Boston 14, Mass

Founder.....LOUIS A OLNEY (Deceased)

Chairman of the Executive Committee on Research....LEONARD S LITTLE, 101 West 31st Street, Room 1500, New York 1, N Y

Director of Research....HAROLD W STIEGLER, Lowell Technological Institute, Lowell, Mass

Standing Committees of the Council

Technical Committee on Research.....CHARLES W DORN, *Chairman*
Publicity.....GEORGE H SCHULER, *Chairman*
Conventions.....KENNETH H BARNARD, *Chairman*
Appropriations.....ALBERT E SAMPSON, *Chairman*
Constitution and Bylaws.....HAROLD C CHAPIN, *Chairman*
Membership and Local Sections.....SAMUEL L HAYES, *Chairman*
Corporate Membership.....ALBERT E JOHNSON, *Chairman*
Publications.....PERCIVAL THEEL, *Chairman*
Technical Programs.....WALTER M SCOTT, *Chairman*
Technical Supplies.....HAROLD C CHAPIN, *Chairman*

Councilors

Representing Sections

NEW ENGLAND REGION

Northern New England: ELMER E FICKETT, JOHN P PLOUBIDES, ROBERT D ROBINSON, SAWYER F SYLVESTER
Rhode Island: ERNEST J CHORNYEI, RAYMOND W JACOBY, THORWALD LARSON, EDWARD W LAWRENCE
Western New England: RAYMOND J CAREY

CENTRAL ATLANTIC REGION

Hudson Mohawk: ALBERT E HERRMANN, JR, JOHN J HANLON
New York: ROBERT C ALLISON, MATTHEW J BABEY, CHARLES W DORN, WELDON G HELMUS, PATRICK J KENNEDY, PAUL J LUCK, JAMES J MARSHALL
Philadelphia: CARLETON T ANDERSON, EDWARD C DIEHL, HARRY L MORGAN, ANGE E RAIMO, ERNEST E RETTBERG, JR, JACKSON A WOODRUFF

SOUTHERN REGION

Piedmont: HARLEY Y JENNINGS, JOSEPH LINDSAY, JR, M M McCANN, RAPHAEL E RUPP, R HOBART SOUTHER
South Central: JOSEPH D MOSHEIM
Southeastern: S JACK DAVIS, H GILLESPIE SMITH
Washington: WALTER M SCOTT

WESTERN REGION

Mid-West: ARTHUR T BRAINERD, SAMUEL KLEIN, ELLIOTT MORRILL
Pacific Northwest: GEORGE S BARKER
Pacific Southwest: ANGUS ROBERTS

Past Presidents

ELVIN H KILLHEFFER, P J WOOD, WILLIAM H CADY, ALBAN EAVENSON, CARL Z DRAVES, THOMAS R SMITH, WILLIAM D APPEL, HENRY F HERRMANN, C NORRIS RABOLD

Local Section Officers

New England Region

NORTHERN NEW ENGLAND

Chairman.....ERNEST R KASWELL, Fabric Research Laboratories, Inc, 665 Boylston St, Boston 16, Mass
Secretary.....AZEL W MACK, Dexter Chemical Corp, 581 Boylston St, Boston 16, Mass
Vice-Chairman—JOHN M GOULD *Treasurer*—WILLIAM W PENNOCK

RHODE ISLAND

Chairman.....ARTHUR F McLEAN, Glenlyon Print Works, Phillipsdale, R I
Secretary.....CHARLES F STOKES, Carbic Color & Chemical Co, 87 Weybosset St, Providence, R I
Vice Chairman—REMUS F CARROSELLI
Treasurer—J WILLIAM TIMPERLEY

WESTERN NEW ENGLAND

Chairman.....ARTHUR S NYQUIST, American Cyanamid Co, 1937 W Main St, Stamford, Conn
Secretary.....NATHANIEL J GLADE, American Cyanamid Co, 1937 W Main St, Stamford, Conn
Vice Chairman—SOCRATES V VANIOTIS
Treasurer—THOMAS G GILLICK

Central Atlantic Region

HUDSON-MOHAWK

Chairman.....IRWIN J SMITH, Surpass Chemical Co, 1254 Broadway, Albany 1, N Y
Secretary.....WILLIAM A NELSON, Ritter Chemical Company, Inc, 403 W Main St., Amsterdam, N Y
Vice-Chairman—HARVEY GENDREAU *Treasurer*—JOHN W MERRILL

NEW YORK

Chairman.....WELDON G HELMUS, Fair Lawn Finishing Co, Fair Lawn, N J
Secretary.....NORMAN A JOHNSON, American Dyestuff Reporter, 44 East 23rd St, New York 10, N Y
Vice-Chairman—JOHN H HENNESSEY *Treasurer*—GEORGE A JONIC

PHILADELPHIA

Chairman.....FREDERICK V TRAUT, Globe Dye Works Co, 4500 Worth St, Philadelphia 24, Pa
Secretary.....THOMAS J SCANLON, Dexter Chemical Corp, P O Box 657, Springfield, Delaware County, Pa
Vice Chairman—THOMAS H HART *Treasurer*—PERCIVAL THEEL

Southern Region

PIEDMONT

Chairman.....HENRY A RUTHERFORD, School of Textiles, N C State College, Raleigh, N C
Secretary.....CLARENCE HOOPER, Burlington Mills Corp, Burlington, N C
Vice-Chairman....H J JORDAN, JR *Treasurer*....C O STEVENSON

SOUTH CENTRAL

Chairman.....PAUL O ANDERSON, Peerless Woolen Mills, Rossville, Ga
Secretary.....WILLIAM F LUTHER, Dixie Mercerizing Co, Chattanooga 1, Tenn
Vice Chairman—JOE T BOHANNON, JR *Treasurer*—J C WHITT

SOUTHEASTERN

Chairman.....T HOWARD McCAMY, Pepperell Mfg Co, Lindale, Ga
Secretary.....JOHN C COOK, W R C Smith Publishing Co, 806 Peachtree St, N E, Atlanta, Ga
Vice-Chairman.....W B GRIFFIN *Treasurer*.....J W SWINEY

WASHINGTON

Chairman.....MILTON HARRIS, Harris Research Laboratories, 1246 Taylor Ave, N W, Washington 11, D C
Secretary.....GEORGE S BUCK, JR, National Cotton Council of America, 1832 M St, N W, Washington 6, D C
Vice-Chairman—HENRY D BARKER *Treasurer*—HERBERT A EHRMAN

Western Region

MID-WEST

Chairman.....J GORDON STOTT, Ciba Co, Inc, 325 West Huron St, Chicago 10, Ill
Secretary.....HARRY W ERICSON, American Aniline Products, Inc, 820 South Clinton St, Chicago 7, Ill
Vice Chairman—ARTHUR I HULTBERG *Treasurer*—JACK G KELLEY

PACIFIC NORTHWEST

Chairman.....DON E ADAMS, Portland Woolen Mills, 6639 North Baltimore Ave, Portland 3, Ore
Secretary....THEODORE M MARSHALL, Nyanza Color and Chemical Co, Inc, 115 SW Fourth Ave, Portland 4, Ore
Vice-Chairman—ROBERT E NEWMAN *Treasurer*—JOHN L AYRES

PACIFIC SOUTHWEST

Chairman.....SIDNEY SPRINGER, 311 South San Pedro St, Los Angeles 13, Calif
Secretary.....CLARICE H LINDSEY, Univ of California, Dept of Home Economics, Los Angeles 24, Calif
Vice-Chairman—ROBERT C ROTH *Treasurer*—SERGIO M DADONE

Student Chapters

BRADFORD DURFEE TECHNICAL INSTITUTE, CLEMSON COLLEGE, FAIRLEIGH DICKINSON COLLEGE, GEORGIA INSTITUTE OF TECHNOLOGY, LOWELL TECHNOLOGICAL INSTITUTE, NEW BEDFORD INSTITUTE OF TEXTILES AND TECHNOLOGY, NORTH CAROLINA STATE COLLEGE, PHILADELPHIA TEXTILE INSTITUTE, RHODE ISLAND SCHOOL OF DESIGN, UTICA TECHNICAL INSTITUTE

CALENDAR

AATCC

COUNCIL
1954—Apr 30 (Atlantic City), June 15, Sept 15, Nov 19.
1955—Jan 21, Apr 15, June 17

NATIONAL CONVENTIONS
Sept 15-18, 1954 (Atlanta Biltmore, Atlanta, Ga); Sept 21-23, 1955 (Chalfonte-Haddon Hall, Atlantic City, N J; 1956 (New York); 1957 (Boston).

HUDSON-MOHAWK SECTION
March 5; April 9, May 14 (Albany); June 18 (Outing).

NEW YORK SECTION
Feb 26 (Hotel Statler, N Y); April 9 Fairleigh Dickinson College); May 14 (Swiss Chalet); June 18 (Outing, North Jersey Country Club, Wayne, N. J).

NORTHERN NEW ENGLAND SECTION
Apr 9 (Lowell Tech, Lowell, Mass); June 11 (Outing—Merrimack Valley C C, Methuen, Mass); Oct 8 (Colonial C C, Lynnfield, Mass); Dec 10 (Woodland Golf Club, Auburndale, Mass).

PIEDMONT SECTION
Apr 10 (Hotel Roanoke, Roanoke, Va); June 11-12 (Outing, Mayview Manor, Blowing Rock, N C); Sept 11 (Hotel Barringer, Charlotte, N C).

PHILADELPHIA SECTION
Feb 26, Apr 9 (Kugler's Restaurant, Philadelphia, Pa); May 21 (Outing—Manufacturers Golf & Country Club, Oreland, Pa); Sept 24, Oct 29 (Penn-Sherwood Hotel, Philadelphia, Pa); Dec 3 (Kugler's).

RHODE ISLAND SECTION
Feb 25 (Johnson's Hummocks Grill, Providence); Mar 25 (Prov Eng Soc); Apr 29 (Wannamoisett Country Club, Rumford, R I); June 11 (Outing—Wannamoisett C C); Oct 14 (Johnson's); Dec 2 (Annual Meeting—Sheraton Biltmore, Providence, R I).

SOUTH CENTRAL SECTION
Feb 27, April 24 (Hotel Patten, Chattanooga, Tenn); June 4-5 (Summer Outing—Chattanooga Golf and Country Club); Dec 4 (Hotel Patten, Chattanooga).

SOUTHEASTERN SECTION
Mar 27 (Ralston Hotel, Columbus, Ga); May 14-15 (Outing—Radium Springs, Ga); Dec 11 (Atlanta-Biltmore, Atlanta, Ga).

WASHINGTON SECTION
Mar 5 (Textile Museum, Washington, D C).

WESTERN NEW ENGLAND SECTION
Mar 19 (Rapp's Restaurant, Shelton, Conn); May 14 (Ladies Night—Waverly Inn, Cheshire, Conn); June 18; Oct 1, Nov 12, Dec 10 (Rapp's).

EMPLOYMENT REGISTER

54-1

Education: high school, and college courses in business administration and chemistry.

Experience: superintendent of dyeing, bleaching and finishing, cotton and rayon.

Age: 37; married; references; position as superintendent, or in technical sales, in South, preferred.

2-15, 3-1

54-2

Education: BS, textile chemistry & dyeing.

Experience: research, development, and application in synthetic fibers.

Age: 28; single; references; position in technical service desired, development or sales, Southeast preferred but not essential.

2-15, 3-1

OTHER EVENTS

AMERICAN CHEMICAL SOCIETY
National Chemical Exposition—Oct 12-15, Chicago, Ill.

AMERICAN MANAGEMENT ASSOCIATION
23rd National Packaging Exposition—April 5-8, Convention Hall, Atlantic City, N J.

AMERICAN SOCIETY FOR QUALITY CONTROL
Meeting of the Carolinas Section—April 2, Clemson, S C.
Conference of the Carolinas, Georgia, Tennessee, Birmingham and Huntsville Sections—Nov 5-7, Chattanooga, Tenn.

AMERICAN SOCIETY FOR TESTING MATERIALS
Committee D-13 (Textile Materials)—Mar 17-19, Hotel Statler, New York, N Y.
Annual Meeting—June 13-18, Sherman and Morrison Hotels, Chicago, Ill.

AMERICAN TEXTILE MACHINERY ASSOCIATION
Exhibit of American Textile Machinery, April 26-May 1, Atlantic City Exhibition Hall, Atlantic City, N J.

CANADIAN ASSOCIATION OF TEXTILE CHEMISTS AND COLOURISTS
Meetings of the Quebec Section—Feb 20, Mar 20, April 23-24 (Montreal, Que); June 19 (Annual Golf Tournament).

CHAMBRE SYNDICALE TRAMAGRAS
International Detergent Congress—Aug 30-Sept 5, The Sorbonne, Paris, France.

DELTA KAPPA PHI FRATERNITY
1954 National Convention—April 2-3, Raleigh, N C.

DRYSALTERS CLUB OF NEW ENGLAND
April 30 (Hotel Vendome, Boston); June 25 (Annual Outing, Andover Country Club).

THE FIBER SOCIETY
Spring Meeting—May 5-6, Monticello Hotel and Thomas Jefferson Inn, Charlottesville, Va.
Fall Meeting—Sept 13-14, McGill University, Montreal, Canada.

INTERNATIONAL CONGRESS OF MAN-MADE FIBERS
May 31-June 3, Paris, France

LOWELL TECHNOLOGICAL INSTITUTE ALUMNI ASSOCIATION
Annual Reunion—April 28, Haddon Hall, Atlantic City, N J.

NATIONAL COTTON COUNCIL OF AMERICA
Cotton Research Clinic—Feb 17-19, The Carolina, Pinehurst, N C.

NEW YORK BOARD OF TRADE (DCAT)
28th Annual Dinner, March 4 (Waldorf-Astoria, New York, N Y).

PHI PSI FRATERNITY
51st Annual Convention, Feb 25-27 (The Carolina, Pinehurst, N C).

SOCIETY OF CHEMICAL INDUSTRY
Plastics and Polymers Group Meeting—March 24-26, Institution of Electrical Engineers, Savoy Place, London, England.

SOUTHERN MUNICIPAL AND INDUSTRIAL WASTE CONFERENCE
Third Annual Conference—March 18-19, N C State College, Raleigh, N C.

SOUTHERN TEXTILE EXPOSITION
October 4-9 (Textile Hall, Greenville, S C).

TEXTILE TECHNICAL FEDERATION OF CANADA
Exhibit—April, 1955, Show Mart, Montreal.

THE APPLICATION OF VAT DYES

Monograph No. 2 of the

American Association of Textile Chemists and Colorists

"The group of fifteen editors responsible for this monograph consists of a well-balanced cross-section of American industry concerned with the production, marketing and application of vat dyes. The AATCC is to be congratulated on the production of a comprehensive survey of American vat dyeing and printing practice which is the major theme of this application . . . the book will be useful as a work of reference at this side of the Atlantic and as a working manual for the American colorists for whom it was designed. . . . If a clear account of American practice is required . . . the enquirer *must* have access to this volume".—*JOURNAL OF THE TEXTILE INSTITUTE* (England).

"This book . . . is abreast of the latest technical developments and research. Its value is increased because of the lack of books in this field today . . . we can readily recommend this book to all technical and practical men".—*MELLIAND TEXTILBERICHTE* (Germany).

"This monograph contains the work of many mill-experienced authors, plus good, sound chemical and application principles developed in the laboratories and mills enjoying AATCC membership. . . . This book puts between two covers much information that a dyer is constantly searching for. It is a good investment for any laboratory, dyehouse, or printshop."—*TEXTILE WORLD.*

". . . this monograph should be in the hands of every user of vat dyestuffs, every student and every teacher. The book is well indexed and includes valuable lists of equivalent trade names. It will certainly take its place as a standard book of reference".—*JOURNAL OF THE SOCIETY OF DYERS AND COLOURISTS* (England).

The price of "The Application of Vat Dyes" is $5 per copy, postpaid, to members; to nonmembers it is $6 per copy. Send your check or money order to the

SECRETARY AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS

P O BOX 28, LOWELL, MASSACHUSETTS

New York Section——

NEW TEXTILE FIBERS WITH THE STRUCTURAL ELEMENTS OF NATURAL CELLULOSIC FIBERS*

JACK COMPTON
Technical Director
Institute of Textile Technology, Charlottesville, Virginia

Cotton, which is by far the most important commercial fiber in use and which continues to hold the leading place in textiles, is so useful not only because large amounts are economically available but also because cotton as a fiber is most versatile in its adaptability to many purposes. By chemical modification of the cellulose constituting cotton it is possible to maintain the natural structure of the fiber, which has great engineering advantages, to obtain new desirable properties. Mercerization has long been employed for this purpose, and now cyanoethylation offers even greater possibility of improvement with retention of fiber structure. Cyanoethylation has been shown to increase the resistance of cotton to mildew and bacterial attack, to give greater heat resistance, greater abrasive resistance, and increased affinity for dyestuffs. Acetylation without solution of the cellulose may also be employed especially to obtain greater heat and biological resistance.

The structures of natural cellulosic fibers are rather fully described by the author so as to make clear why chemical treatment without alteration of that structure is advantageous.

INTRODUCTION

Of the approximately one hundred useful vegetable fibers only three are used to any appreciable extent in fabrics—cotton, flax and ramie—in that order of importance*(1)*. The cotton fiber is classified with the seed and fruit hair fibers, whereas flax and ramie are included with the bast and leaf fibers. Although other vegetable fibers, particularly bast and leaf fibers, find many other uses than in fabrics, these are adequately represented by the bast fibers mentioned. The vegetable fibers are characterized by a preponderance of cellulose, which has the same molecular structure regardless of source. At the molecular level all vegetable fibers are thus subject to modification resulting from the reaction of the cellulosic component with certain chemicals to form stable derivatives. If the proper conditions for reaction are employed, the intrinsic arrangement of the elements of fiber structure may be preserved while new fiber properties are acquired. In a very real and definite manner, therefore, new families of fibers may be created from each of the vegetable fibers by the proper selection of chemicals and reaction conditions. The possibilities inherent in this approach to the creation of new man-modified fibers for specific end uses could dwarf the much publicized possibilities that exist in the man-made fibers derived from both cellulosic materials in which the natural structure has been largely destroyed and synthetic polymeric fiber materials.

J Compton

STRUCTURAL ELEMENTS OF NATURAL CELLULOSIC FIBERS

The structural elements of natural cellulosic fibers are basically the same, although subject to considerable variation

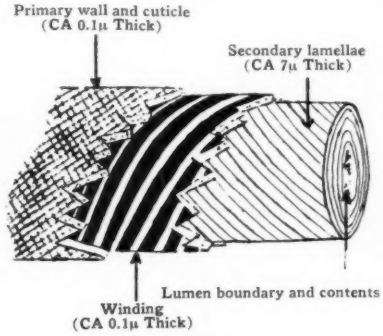


Figure 1

Schematic representation of structural parts of cotton fiber (USDA photo by Southern Regional Research Laboratory)

(2) as follows:

1) Primary wall;
2) Secondary wall; and
3) Lumen, Figures 1, 2, 3, and 4, and Table I.

In the case of the cotton fiber, the outside of the fiber is covered with a thin layer of wax, pectic material, and some encrusting materials, which are presumably largely calcium or magnesium salts of pectic acid, Figure 2.

1) PRIMARY WALL——Some workers differentiate between the cuticle and the primary wall, whereas others consider these to be the same. In the case of the seed hair, cotton, the primary wall of the fiber results from the extension of certain epidermal cells of the developing cotton seed. It reaches its maximum length about twenty days after the cotton flowers. From studies made on the outer limiting membrane of the fiber removed by severe agitation with a Waring Blender, the primary wall seems to be less than 0.2 micron in thickness and to be made up of laminated microfibrils*(3,4,)* 200A (A = angstroms) in diameter, although some fibrils are twice this diameter and some are as small as 100A. The first layer is oriented in a direction parallel to the fiber axis, whereas the second layer is oriented transversely*(5)*. Underneath this is a primary winding, or wide bands of microfibrils about 0.1 micron thick, which spiral around the fiber *(6, 7)*. Other workers have concluded that the cellulose in the primary wall was either randomly arranged *(8)* or that the fibrils lie transverse to the fiber axis*(9)*. The composition of the separated primary wall and that of the entire mature fiber *(4)* is shown in Table II. The contribution of the primary wall to the weight of the cotton fiber has been estimated to be about 5%.

The primary wall of the bast fibers is similar in appearance to that of the cotton fiber, Figure 3 and 4, but differs somewhat in composition.

2) SECONDARY WALL —— The secondary wall of vegetable fibers constitutes the greater part of the fiber and is composed of lamellae consisting of dense and porous, or less dense areas,

* Presented at the October 23, 1953, meeting of the New York Section held at Rochelle Park, N J.

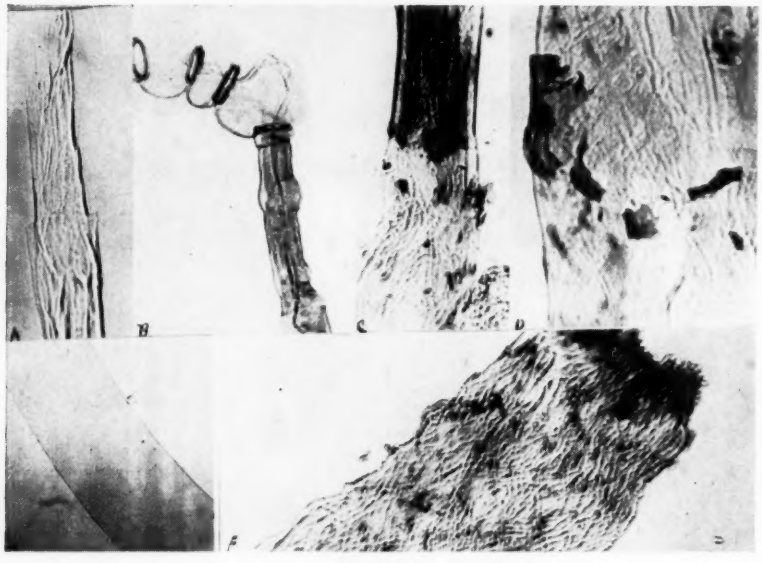


Figure 2
Components of cotton fiber

A) Fifteen-day-old cotton fiber, from which transparent outer membrane is partially removed
B) Effect of this relatively insoluble outer membrance during swelling of a dyed fiber in cuprammonium hydroxide.
C) Partially removed outer membrane of a dyed cotton fiber affects swelling in cuprammonium hydroxide.
D) Flakes of outer membrane upon the surface of a dyed cotton fiber during swelling in cuprammonium hydroxide.
E) Hollow cylinder of outer membrane material from a mature cotton fiber shows its microscopically structureless nature at this magnification.
F) Fibrillar structure of the secondary lamellae of a dyed cotton fiber, from which the outer membrane had been removed during swelling in cuprammonium hydroxide. (Courtesy of Wanda K Farr).

Figures 1 and 2. It is claimed by some that a lamella is deposited each day after the primary wall has reached its maximum elongation *(10)*. The dense area being deposited at night as the result of active photosynthesis of cellulose during the day, and the less dense area during the day—— there being little photosynthesis during the night *(11)*. There would normally be about thirty to forty lamellae in a cotton fiber regardless of fiber diameter. The so-called daily growth rings, or lamellae are claimed to be analogous to the annual growth rings observed in the cross section of trees but are deposited in the inverse order. Considerable doubt exists, however, regarding the accuracy of these observations since it has been pointed out that the "growth rings" may only be artifacts resulting from pressure on the cover glass of the microscopic mount of the highly swollen fiber cross section*(12)*.

The existence of lamellae in the secondary wall remains unquestioned, but confusion exists regarding the number present. The observation that the number of lamellae in a fiber cross section is dependent upon the cell-wall thickness of the fiber appears to be logical. Thus, thin-walled fibers and very fine mature fibers would have fewer lamellae than either thick-walled or course mature fibers. Since each dense area of the lamellae has been observed to be about 1 micron thick and little changed by swelling agents in contrast to the less dense or porous areas, then the number of lamellae in a fiber 20 microns in diameter will be eight or nine,

TABLE II
CHEMICAL COMPOSITION OF TYPICAL COTTON FIBER AND PRIMARY WALL

Constituent	*% of Dry Weight* Fiber*	*Primary Wall*
cellulose	94	54
protein (%N x 6.25)	1.3	14
pectic substance	1.2	9
wax (alcohol soluble)	0.6	8
ash	1.2	3
cutin/suberin (?)	...	4

* Moisture regain of fiber, 8%; of primary wall, 13%.

whereas a fiber 10 microns in diameter will have four or five. A cotton fiber is usually far from being perfectly cylindrical in shape but often has constrictions and distentions along its length. It would thus appear that the observation that the number of lamellae varies with the fiber diameter is more plausible than that the thickness of the lamellae varies with the fiber diameter——a necessary conclusion from the daily-growth-ring hypothesis. A correct understanding of the properties of the lamellae is very helpful in attempting to improve the physical properties of the entire fiber by selective chemical reactions. The two gross components of the lamellae should thus be given further consideration.

a) *Amorphous or Less Dense Area*—— Between successive crystalline areas lies an amorphous or less dense area. When the cotton fiber is treated with swelling agents the amorphous area cementing the dense areas together increases in thickness to a much greater extent than the dense areas, Figures 1 and 2. This less dense area appears to be made up of amorphous cellulose or cellulose molecules in a disordered state. The molecules composing this area may not be of the structure ascribed to cellulose but rather hybrid molecules of cellulose with certain other foreign structural units of a similar nature to those comprising pentosans and uronic acids in the case of the cotton fiber. In bast fibers pentosans and lignin residues may also be present. The possibility exists that this area is composed of disorganized ends of molecules or fringe from the organized crystalline component comprising the dense area. There is some evidence that indicates that the "cellulose" molecules in this area may be shorter in length and branched off of the molecules comprising the dense crystalline area of the lamellae. The composition and chemistry of this component of the lamellae remains obscured and further work is needed.

b) *Crystalline or Dense Area*——The portion of the lamellae which increases very little in thickness in the presence of swelling agents for the cotton fiber, upon examination in polarized light or by x-rays, is found to be crystalline in nature. This cylindrical sheath is composed of many long continuous strands, or

TABLE I
APPROXIMATE SIZES OF MAJOR FIBERS AND CELLS

Fiber	*Type of fiber*	*Apparent Fiber Length cm*	*Fiber Width mm*	*Cell Length mm*	*Cell Width μ*
cotton	seed-hair	1.5-5.6	0.012-0.025	15-56	12-25
flax	bast	20-140	0.04-0.62	4-66	12-76
jute	bast	150-360	0.03-0.14	0.8-5	10-25
hemp	bast	100-300	....	5-55	16-50
ramie	bast	10-180	0.06-9.04	60-250	16-126
Manila hemp	leaf	180-360	0.01-0.28	3-12	12-46
sisal hemp	leaf	75-120	0.10-0.46	1.5-4	16-32
wood	stem	....	....	0.14-5	variable

fibrils aligned side by side and spirally wound around the fiber. Upon tearing the ends of these fibrils from the sheath, they have been found to be about 1 micron in diameter and possibly extending the length of the fiber, Figures 1 and 2. Occasionally, reversals of the fibril spirals occur in a given lamella, and some consider these to be potential weak spots along the fiber, whereas others do not. Some workers have found the fibrils to be as small as 0.3 to 0.5 micron in diameter (*13*), whereas others believe that they have no limiting or fixed dimensions but grade downward from about 1 micron to molecular dimensions (*14*). The material separating and binding the fibrils together in a continuous sheath or shell is presumed to be similar to the material comprising the amorphous or less dense area of the lamella regardless of fibril dimensions. The only exception to this is found when the fibril dimensions are reduced to that of the cellulose molecule, and in this case the binding force is ascribed to hydrogen bonding, Van der Waal forces, or other forces operating at the molecular level. From x-ray and polarized-light studies it has been found that the fibrils in the secondary wall lamellae alternate in the direction of spirality. This relation may not be precise, but it is sufficiently true that the acute angle may be determined without difficulty. In general, cotton fibers showing the smallest angle between spiral layers with respect to the fiber axis are the stronger fibers (*15, 16*). The acute spiral angle varies from 22 to about 45°.

Attention is called to the fact that, when vegetable fibers are purified, extraneous materials are removed and structural elements of the secondary wall are predominantly left behind. At the same time short-chain molecules may be removed, which are similar to those remaining in molecular structure, and perhaps the molecules remaining may be changed in some important respects.

When vegetable fibers are subjected to the degrading action of acids, oxidizing agents, and enzymes or other complexes derived from micro-organisms, amorphous areas seem to be involved first, followed eventually by the slower reacting crystalline or fibril sheath comprising the lamellae. In order to understand these reactions more completely, it is necessary to give consideration to the molecular constitution of cellulose and arrangement of the molecules in the unit cell of the crystalline area.

(3) LUMEN———The cotton fiber during development is a single-cell organism with a nucleus and cytoplasm. As successive layers of the secondary wall are built up, the volume available for the cytoplasm decreases. When the cotton fiber reaches maturity about thirty-five days after the primary wall and cuticle cease to extend, syneresis begins. The cell sap is lost and the residual protoplasm is left in the elongated opening in the center of the fiber (*17*). This central opening in the fiber is known as the lumen, Figure 1. Upon purification the lumen dimension varies with both the variety of cotton and the environmental conditions under which the cotton is grown. In general, mature cottons have comparatively small lumens whereas immature cottons have large lumens (*18*), Table III.

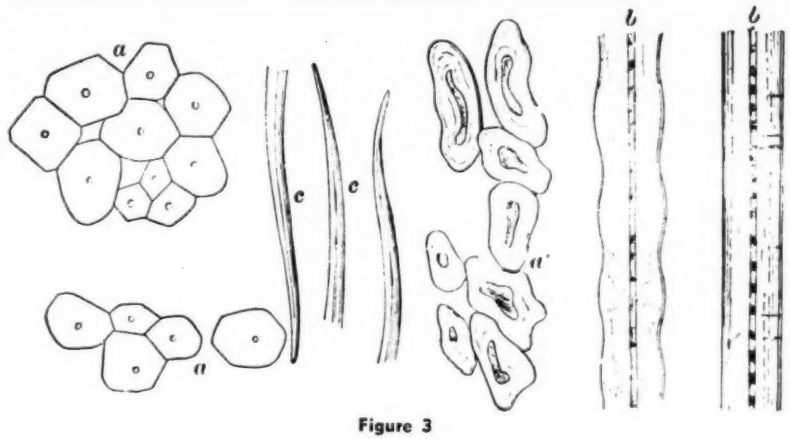


Figure 3
Flax fibers
a,a', Cross sections; b, longitudinal views; c, ends
(Cross and Bevan)

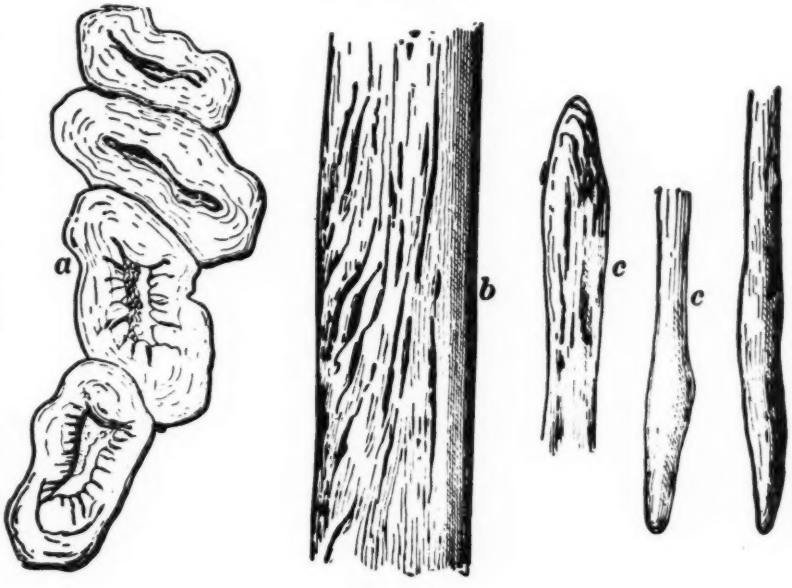


Figure 4
Ramie fiber
a, Sections; b, longitudinal view; c, ends
(Cross and Bevan)

TABLE III
AVERAGE CROSS-SECTIONAL FEATURES OF COTTONS IN FOUR RANGES OF FINENESS

Samples	Areas, μ²			Diameters, μ				Fiber Ratio Major to Minor	Av Wall Thickness, μ
				Lumen		Fiber			
	Total	Lumen	Net	Major	Minor	Major	Minor		
Very fine	98.90	10.54	88.38	9.77	1.20	16.73	6.20	3.07	2.50
Fine American Upland	155.26	11.89	143.37	10.92	1.05	20.02	7.83	2.77	3.39
Coarse American Upland	230.05	19.02	211.04	14.22	1.55	24.97	9.49	2.90	3.97
Very coarse Asiatic	374.26	27.49	346.78	12.53	2.24	27.26	14.57	2.07	6.17

MOLECULAR AND UNIT-CELL STRUCTURE OF CELLULOSE AND ARRANGEMENT IN FIBRILS

The elements of structure remaining to be discussed are the following: 1) Cellulose molecules; 2) Unit-cell structure of the crystalline cellulose; and 3) The arrangement of these structural elements in fibrils.

MOLECULAR CONSTITUTION OF CELLULOSE——The acepted molecular constitution of cellulose (*19*) is shown in Figure 5. It will be noted that it is a polymer of anhydro-D-glucose units bound together by 1, 4 oxygen bridges. The total number of anhydro-D-glucose units in the average molecule of native cellulose *(n)* from various sources has been reported (*20*) to be, for unbleached cotton linters, 9,200; untreated cotton fiber, 6,200; nettle fiber, 10,800; ramie, 11,300; and sulfite wood pulp, 2,900. Other values in the range of 3,000 to 4,000 have also been reported, based upon various methods for the determination of molecular weight.

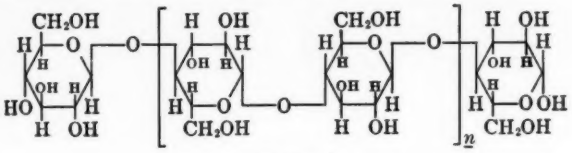


Figure 5

Modern concept of the structure of the cellulose molecule

Another arrangement of the molecule (*21*) is shown in Figure 6. This concept of structure shows the hydrated, open-chain form of cellobiose in conjunction with the terminal open-chain D-glucose polymer units, holding the long anhydro-D-glucose polymer molecules together by hemiacetal linkages. Other simple sugars or sugar derivations may replace cellobiose in this scheme.

It will be noted that, 1) there are one primary and two secondary hydroxyl groups in each basic anhydro-D-glucose unit, the hydroxyls being in positions 2, 3, and 6; 2) the end glucose residues of each cellulose molecule are distinguished from those in the body of the chain by containing either an additional secondary hydroxyl group in position 4 or a reducing hemiacetal group in position 1; and 3) positions 1, 4, and 5, in each anhydro-D-glucose unit are involved in hemiacetal linkages.

UNIT-CELL STRUCTURE ——— The cellulose component of cotton fibers possesses the properties of an anisotropic crystal (*22*), which behaves toward x-rays as a three-dimensional grating and thus indicates a certain regularity of internal structure (*23*).

a) *Long-Chain or Continuous Theory* ———According to the long-chain theory the unit cell contains only a part of the cellulose molecule (*24*). The dimensions of the unit cell of native cellulose, as deduced from x-ray diffraction patterns (25), are indicated in Figure 7. It will be noted that every other cellulose molecule runs in the opposite direction. This is suggestive of the fact that permanent forces are operating, which maintain this statistic balance. The crystalline units of cellulose are represented as repeat periods occurring along continuous chains of glucose residues, which are arranged parallel to the *b* axis of the unit cell with a cellobiose group on each corner and one through the center. The cellulose molecules are held together laterally by secondary valence forces (*26*). The anhydro-D-glucose units in the main valence chains are arranged alternately in such a way that a half turn occurs for each unit length. Adjacent chains in the *a-b* plane are arranged so that the primary hydroxyl groups, position 6, in one anhydro-D-glucose unit is next to the secondary hydroxyl groups, position 3, in the anhydro-D-glucose unit of the neighboring chain. The centers of the two nearest oxygen atoms along the *a* axis of two anhydro-D-glucose units are about 2.5A apart. The close packing found is believed due to hydrogen bonding, since Van der Waals' forces would not cause an approach closer than about 3.0A, and compares roughly to a strength of 15,000 calories per mol.

Along the *c* axis the nearest distance between hydroxyl groups of adjacent chains is about 3.8A, corresponding to the distances that would be expected if Van der Waals' forces hold the molecules in this direction together. These forces cor-

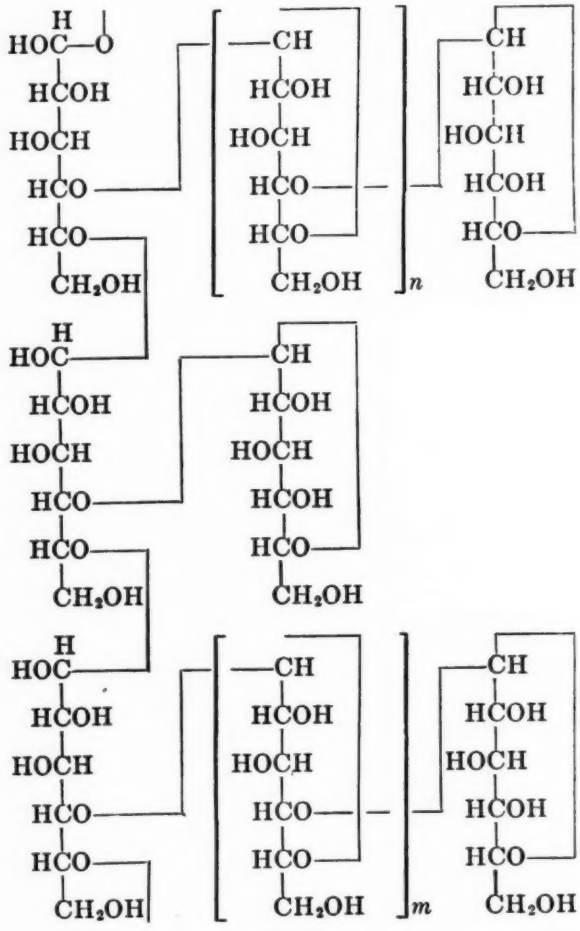


Figure 6

Cellulose according to the Pacsu concept

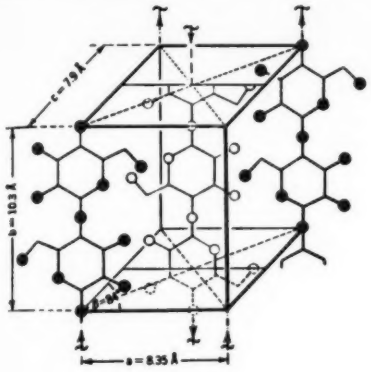


Figure 7
Unit-cell of native cellulose (Meyer and coworkers)

respond to a strength of about 8,000 calories per mol.

Along the *b* axis, the main valence chains are held together by 1,4 glucosidic bonds. The strength of these bonds is of the order of 50,000 calories per mol.

It has been pointed out *(27)* that cellulose chains at different distances apart held together by three different kinds of forces in three different directions in space may be partly responsible for the important properties that cellulose fibers exhibit. The approximate strengths of various vegetable fibers *(28)* are shown in Table IV.

b) *Micelle or Discontinuous Theory*——In contrast to the long-chain theory, the micelle theory accounts for imperfections in fiber crystallinity as being due to the presence of amorphous areas between discrete crystalline bundles of molecules. The long-chain, or continuous, theory thus opposes the discontinuous, or micelle, theory. Originally, *(22)* micelles were thought to consist of bundles of 40 to 50 chains of glucose residues, each chain containing 100 to 200 anhydro-D-glucose units, held together by either an amorphous cementing material or by tertiary forces similar in nature to Van der Waals' forces. The micelles of Nageli were thus below the limit of microscopic visibility. In contrast to this, the cellulose particles of Farr and Eckerson *(29)* are microscopic in size, being 1.1 micron thick and 1.5 micron in length. According to the particle concept the fiber wall is made up mostly of particulate crystalline cellulose, which diffracts x-rays, is doubly refracting in polarized light, and is surrounded by a thin sheath of amorphous and isotropic noncellulosic material. The conclusion is drawn that they are fundamental building units since the particles are observed in the living cytoplasm of young cotton fibers *(12)*.

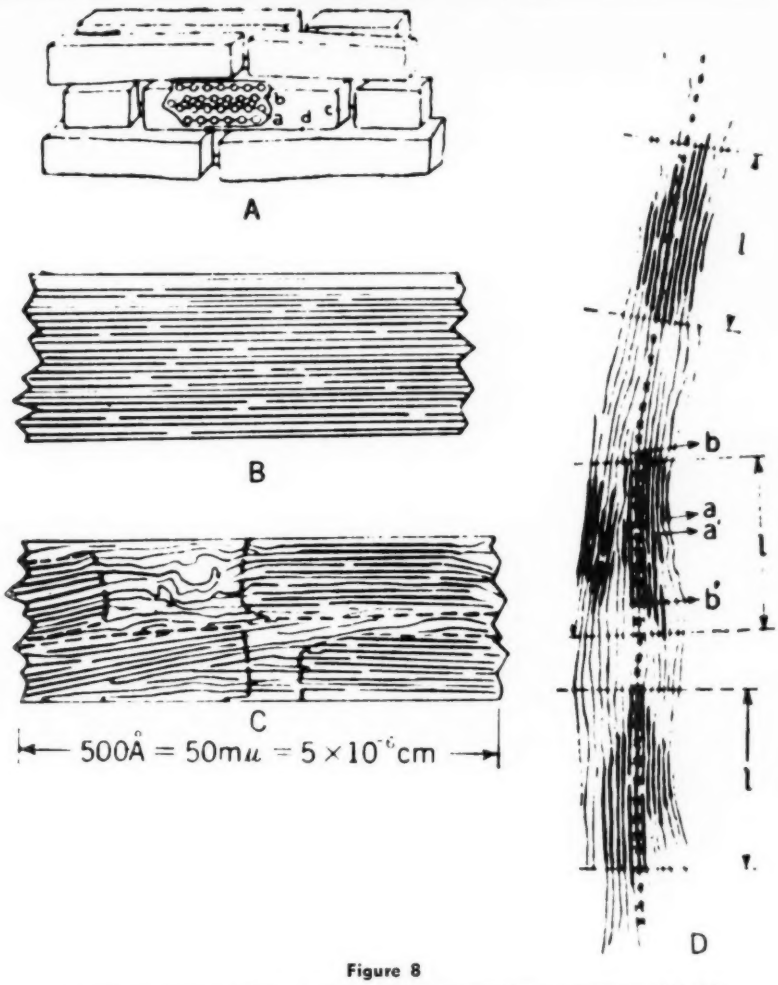


Figure 8
Schematic representation of several possible crystallite structures (Mark)

(A) Micellar theory (Seifriz); (B) continuous-structure theory; (C) fringe-micellar theory. How main valence chains pass through more than one micelle (fringe-micellar theory) is shown in (D). a, a', b', molecule ends inside the crystallized region of one micelle. b, molecule ends outside the crystallized region. l, length of crystallized region.

TABLE IV

APPROXIMATE STRENGTHS OF MAJOR VEGETABLE FIBERS

Fiber	*Range kg per sq mm*	*Average kg per sq mm*	*Elongation %*	*Mean Breaking Length,* km*
Cotton	35-80	55	6.8	30
Flax	40-100	80	1.6	52
Jute	40-80	60	0.8	33
Hemp	80-92	85	1.6	55
Ramie	70-80	75	2.7	50
Wood (grain direction)	7-15	11	..	5

* Length required to break under own weight.

ARRANGEMENT OF CELLULOSE MOLECULES AND/OR UNIT-CELL STRUCTURE IN THE FIBRIL——It seems that neither the continuous long-chain theory nor the discontinuous short-chain theory adequately satisfy all the accumulated evidence. It is now thought that discontinuities occur along the bundles of cellulose molecules in either some periodic manner or at random. These faults in the crystalline structure in either case result in fringe areas, which may be thought of as amorphous cellulose. This is shown in Figure 8. Electron-microscope studies seem to indicate that the large fibrils, one micron and larger, found in the secondary wall of the fiber, may be broken and split into smaller fibrils. This process may continue until unit cell, or thereabout, dimensions are reached. From

x-ray studies it is surmised that the ultimate micelle is about 50A wide and at least 500A long. Estimates from the chain length of hydrolyzed cellulose *(30)* show that the more highly crystalline regions in cotton consist of 280 anhydro-D-glucose units about 1450A long. Within the limits of electron-microscope technique the diameter of the finest particle appears to vary in any one sample *(31)*, Figure 9. The approximate average diameters found were as follows: cotton, 100A; cotton linters, 160A; ramie, 100A; and wood pulp, 90A. Evidence that fine fibrils are aggregated into units of a larger size, such as fibrils several tenths of a micron in diameter, was not found. Although bundles near this size can be found, both larger and smaller bundles were also present. In the case of cotton, the fine fibrils seemed to be arranged in layers. These layers were found to be about 0.1 micron in thickness.

CHEMICALLY MODIFIED VEGETABLE FIBERS

From the above considerations, the conclusion must be drawn that the vegetable fibers, as represented by cotton, ramie, and flax, have very intricate structures that will probably never be duplicated in the laboratory. It would seem that the preservation of the structure would be most desirable, since the versatility, particularly of cotton, is proof of the engineering value of nature's structure. In 1952 cotton alone accounted for 69.6 per cent of the apparel-type fibers consumed in the United States *(32)*. Although the percentage of cotton used for this purpose has declined from the 89-percent value reached in 1920, the per-capita consumption increased from 25 to 35 pounds during the same period, and the actual consumption of cotton in the United States has increased from 2,800,000,000 to 4,500,000,000 pounds per year. During the same period rayon and acetate consumption increased from 0.3 to 19 per cent and from zero to 4 per cent for the newer synthetic fibers. When competition becomes most keen, however, cotton seems to hold its position in the market better than any other textile fiber. The enviable position of cotton among the textile fibers is due to its outstanding performance under all types of service conditions. Some of these characteristics in relation to other textile fibers may be summarized as follows *(33)*:

- Extremely complex structure
  - Chemically, a complex high polymer
  - Mechanically, a complex laminated structure
- High strength, dry and wet
- High in toughness
- High in affinity for fast and brilliant dyes at ordinary processing temperatures
- High in opacity
- High in flexibility
- Good dielectrical properties
- High in insulation properties
- Thermally stable
- Excellent and perfectly distributed natural finish
- No plastic flow or growth properties under ordinary use conditions
- Available in wide ranges of staple lengths and deniers (finenesses)
- Easily sterilized without damage
- High in absorbency
- Easily and economically manufactured on existing processing machinery
- Good bulkiness with low weight due to
  - Cylindrical construction
  - Natural out-of-phase convolutions and crimp, which prevent packing
- High yarn-strength-to-fiber-strength ratio
- Fabrics are naturally
  - Free of "balling", or pilling, tendencies
  - Completely washable
  - Easy to iron without damage at high temperatures
  - High in comfort
    - Not muggy in warm weather
    - As warm as wool if properly constructed
    - As cool as gossamer if properly constructed
  - Clean feeling
  - Clean appearing
  - Low in static-electricity generation
    - No explosive hazard around flammable organic solvents
    - Does not attract lint and dust
    - Not attracted electrically to other garments
  - Easily bonded to rubber, pyroxylin or plastics
  - Easily cut and sewn
    - No "needle" burn
    - No puckered seams
    - Good in resistance to photochemical degradation
  - Excellent in wearing resistance
  - Good draping properties
  - Good in abrasion resistance
  - Easily scoured, bleached and finished
- Fabrics are easily and cheaply converted for
  - Dimensional stability
  - Softness
  - Stiffness
  - Rot resistance
  - Mildew resistance
  - Heat resistance
  - Soil resistance
  - Bright or dull luster
  - Water repellency
  - Smooth, medium or rough surface
  - Embossed patterns
  - Textured patterns
- Naturally fully compatible with man
  - Neither fiber nor garments are damaged by any chemicals, gases or surfaces that are harmless to man
- Odorless, tasteless
- Versatile in end uses for
  - High-style fabrics
  - Staple consumer goods
  - Rugged mechanical and industrial goods
- Low in cost
- Easily and cheaply insured against price fluctuations.

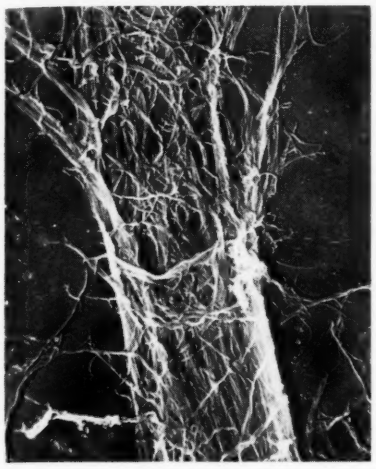


Figure 9

Cotton linters beaten and shadowed with chromium (Hercules Powder Co photograph)

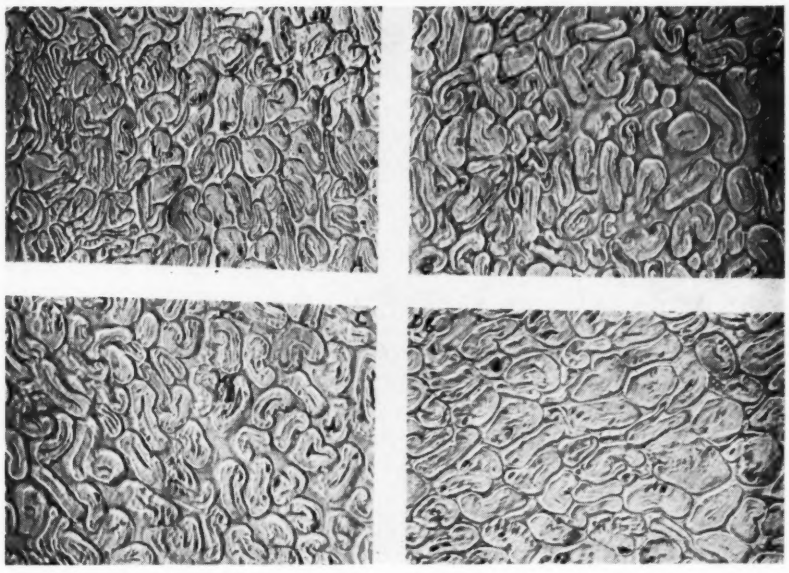


Figure 10

Cross sections of cyanoethylated cotton fiber

A—control, untreated
B—1.6% nitrogen treated
C—2.6% nitrogen treated
D—4.0% nitrogen content

Preservation of these performance characteristics of cotton in any work directed toward chemical modification is thus essential. This of necessity means that the reaction conditions must be mild. In general, the amorphous areas of the cotton fiber are the most easily degraded parts of the structure, yet these areas are also the first to react to form stable derivatives. Chemical modifications that render these areas less susceptible to mechanical, chemical and micro-organism damage would thus appear to be desirable. This approach to the problem of engineering textile fibers to suit particular end uses and purposes has yet to be fully explored. Textile-fiber engineering has in recent years been aided by the development of new textile fibers, which may be placed in the three categories:

1) natural textile fibers chemically modified without disrupting the intrinsic elements of structure;

2) textile fibers derived from natural fibers by chemical reactions, which either permanently or temporarily modify the bonding forces between molecules so that disruption of the intrinsic elements of structure may be induced, following which a new arrangement may be effected; and

3) synthetic polymeric textile fibers with certain structural features characteristic of textile fibers derived from natural fibers.

The discovery of the mercerization process by Mercer *(34)* in 1844 and the improvements effected by Lowe *(35)* in 1889 are illustrative of the first category of fibers. The first man-made fiber from nitrocellulose by Count Hilaire de Chardonnet *(36)* in 1884 as well as the fibers produced by the cuprammonium *(37)*, viscose *(38)*, and acetate *(39,40)* processes are representative of the textile fibers included in the second category.

The third category includes such textile fibers as nylon, which was introduced to the trade in 1938, and, in addition, the more recently developed fibers: Perlon, Vinyon, Orlon, Dynel, Acrilan, and Dacron.

The two chemical modifications of cotton which may be achieved with the least

TABLE V
COMPARISON OF DYEING PROPERTIES OF COTTON AND PARTIALLY CYANOETHYLATED COTTON (80x80) PRINT CLOTH WITH VARIOUS TYPES OF DYES IN CONCENTRATIONS REQUIRED TO OBTAIN SAME SHADE

(The cyanoethylated cotton fabric used in this test contained 1.5% of nitrogen. Ratio of dye liquor to fabric in all cases was 50:1. The concentration is based on the weight of dyestuff to weight of goods.)

Type of dye	*Name*	*Per Cent Decrease in dye used for cyanoethylated cotton fabric*	*Light fastness**	*Wash fastness*	*Wet and dry crocking*
sulfur	Sulfogen Golden Brown RCF	33	—	Cyanoethylated cotton and cotton equal	Cyanoethylated cotton and cotton equal
vat	Ponsol Blue GDD	40	+		
direct	Pontamine Fast Green 5BL	40	—		
direct (copper aftertreat)	Coprantine Blue BLL	40	+		
naphthol	ASSW With Red Salt B	33	+		
developed	Rosanthrene Red 9BL Developed with B-Naphthol	40	—		
basic	Victoria Blue B without mordant	60	+		
acid	Cloth Fast Brilliant Red 38W	—	+		

*+ means cyanoethylated cotton was equal to or better than cotton fabric in Fade-Ometer test.
— means cyanoethylated cotton was not as good as cotton fabric in Fade-Ometer.

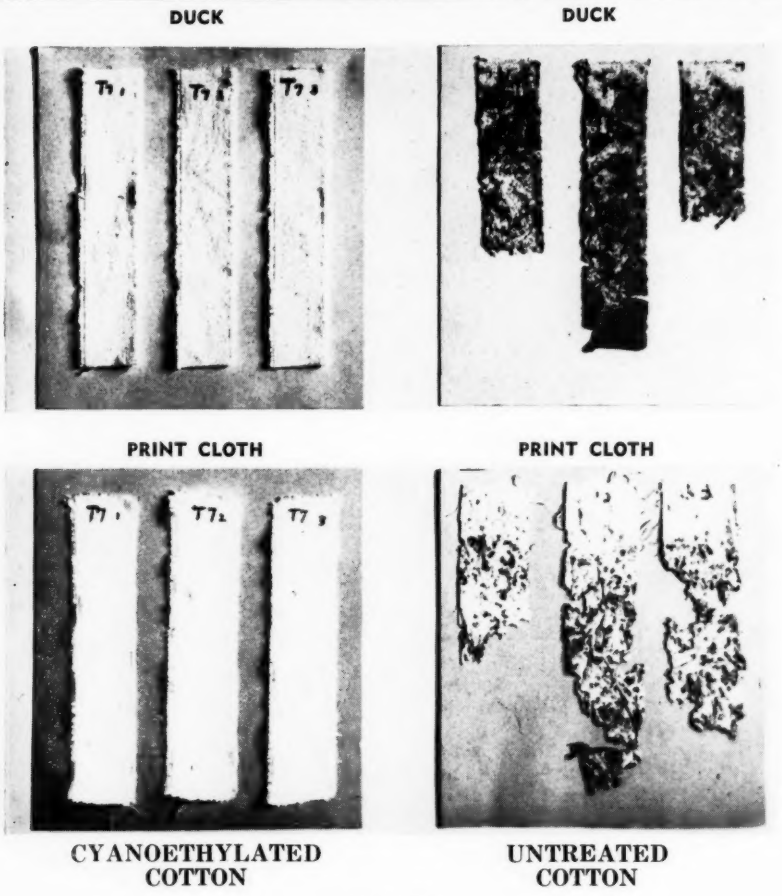


Figure 11
14-day soil-burial test

A comparison of the appearance of cyanoethylated cotton and cotton fabrics after burial in soil at 30° C and 95% relative humidity for two weeks.

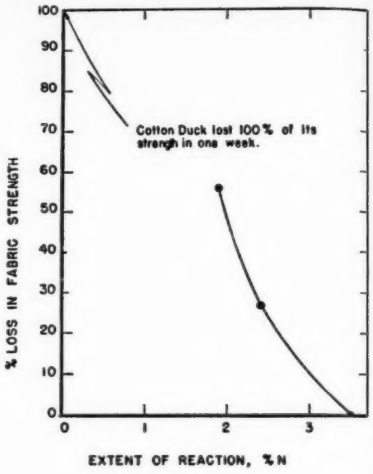


Figure 12
Loss in tensile strength of cyanoethylated cotton fabrics of various nitrogen contents during two weeks soil-burial test.

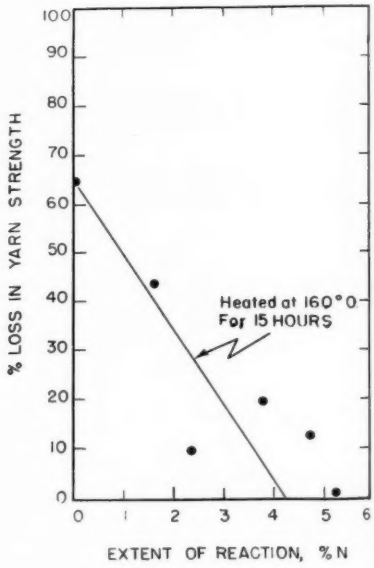


Figure 13
Loss in strength of cyanoethylated cotton yarns of various nitrogen contents during heating at 160°C (320°F) for 15 hours.

disruption of the intrinsic elements of fiber structure are cyanoethylation and acetylation.

CYANOETHYLATION ——— The reaction of acrylonitrile with cotton to produce partially cyanoethylated fiber, yarn, or fabric has been investigated extensively at the Institute of Textile Technology *(41)*. The new fibers retain the appearance, hand, cross-sectional features, and other familiar characteristics of cotton, Figure 10, but take on the following added properties:

1) Permanent resistance to micro-organism attack. such as mildew and bacteria, Figures 11 and 12;
2) Enhanced strength retention after exposure to wet and dry heat, Figure 13;
3) Increased receptivity to all clases of dyes, including acid dyes, Figure 14 and Table V; and,
4) Greater resistance to abrasion, Figure 15.

In addition to this, by treatment of the partially cyanoethylated cotton fibers, yarns, and fabrics with various types of swelling agents for cellulose a further enhancement of certain properties occurs. The use of partially cyanoethylated cotton as a basic fiber material for further treatment thus opens up new approaches to the problem of engineering textile fibers to achieve desirable end-use products.

ACETYLATION———The acetylation reaction, developed in this country by the Southern Regional Research Laboratory of the US Dept of Agriculture *(42)*, confers certain properties to cotton similar to cyanoethylation. This is particularly true regarding resistance to micro-organism attack and enhancement of strength retention during exposure to dry heat.

The processing of cotton to form new fibers is far simpler than polymerization to form polymeric fiber materials, extrusion or spinning to produce man-made fibers. It is true, however, that in the case of man-made cellulosic fibers such as viscose rayon great improvements can be expected if the inherent structural elements of the purified vegetable fibers are disrupted to the least extent consistent with economical production under improved spinning conditions. It was pointed out by the writer in 1939 *(43)* that, "Although it is apparently impossible to produce rayon with all the physical properties of natural cellulosic fiber materials, improvements can be expected upon combining adequate protection of the natural fiber components, both during the purification treatments and in the preparation of viscose, with perfected spinning methods". The procedures proposed for accomplishing this objective thus anticipated

work leading to the development of "BX" rayon yarn *(44)* by Comptoirs des Textiles Artificiels, Paris, France.

Another approach to this problem involves mechanical stretching of the fiber while in a highly swollen or plastic condition. To demonstrate the potentials inherent in this method, mature cotton fibers were taken from an unopened cotton boll and subjected to stress *(45)*. The resulting fibers had an increase in tensile strength amounting to as much as 100%, increased luster, and increased fatigue resistance. Other work has confirmed the potential of this approach *(46)* for increasing the strength of cotton fibers.

From these considerations it would appear that cotton and man-modified cotton fiber augmented by other vegetable fibers and man-modified vegetable fibers may long remain supreme in the textile field.

ACKNOWLEDGMENT

The work herein reported on the cyanoethylation of cotton has been carried out during the past four years with the assistance of a research team composed of Dr W H Martin, B H Word, Jr, Mildred Wetzel, Jerry Garrett, William R Musick, Dr D R Roberts, Dr D D Thompson, Catesby Jones, Kenneth Morrissey, Richard P Barber and R B Sanford. The untiring help of the personnel of the Institute's textile-testing laboratory and of the Research Secretarial Staff is also gratefully acknowledged.

DISCUSSION

Question: We all know that mercerization of cotton increases its tensile strength and its affinity for dyes. In your description of cyanoethylated cotton were you comparing it in these two properties with untreated or mercerized cotton?

Answer: With untreated cotton; mercerized cotton lies between in tensile strength and dye affinity.

Q: What is the effect of cyanoethylation on raw cotton as far as carding, combing, drawing, and spinning are concerned? Is it generally advantageous to treat cotton in the form of raw stock or yarn?

A: We are now trying to find the answer to these questions. If you want to make fiber blends, then the cotton must be treated in stock form. On the other hand, the farther on toward the finished article that cotton is treated, usually the cheaper is the process, that is, the treatment of cotton in fabric form is cheapest. Although the cyanoethylation of cotton yarn in package machines is expensive, it is a convenient way for us to get yarn to work and experiment with.

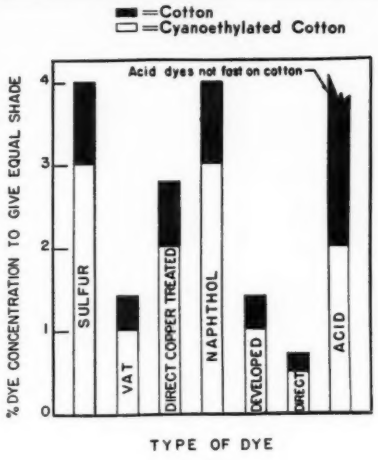


Figure 14

A comparison of the amount of dye used on cyanoethylated and cotton fabrics to obtain equal shades. (The dyes are the same as those described in Table V).

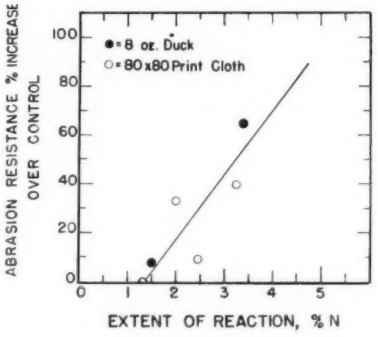


Figure 15

Abrasion resistance (Stoll) of cyanoethylated cotton fabrics of various nitrogen contents.

LITERATURE CITED

(1) *ASTM Committee D-13 Year Book* (1952).
(2) Nickerson, R F, Monograph, *High Polymers*, V, "Cellulose and Cellulose Derivatives". Interscience, New York, 1045 (1943).
(3) Muhlethaler, K, *Biochem et Biophys Acta* 3, 15 (1949).
(4) Tripp, V W, Moore, Anna T, and Rollins, Mary L, *Textile Research J* 21, 886 (1951).
(5) Roelofsen, P A, *Biochem and Biophys Acta* 7, 43 (1951).
(6) Hock, C W, Ramsey, R C, and Harris, M J, *J Research NBS* 26, 93 (1941).
(7) Kerr, T, *Textile Research J* 16, 249 (1946).
(8) Sisson, W A, *Contrib Boyce Thompson Inst* 9 (3), 239-242 (1938).
(9) Berkley, E E, *Textile Research J* 9, 355 (1939).
(10) Balls, W L, *Proc Roy Soc, London* B 90, 542 (1919).
(11) Kerr, T, *Protoplasma* 27, 229 (1937).
(12) Farr, Wanda K, *Contrib Boyce Thompson Inst* 10, 71 (1938); *J Phys Chem* 42, 1113 (1938).
(13) Herzog, R O, and Jancke, W Z, *Physik* 3, 196 (1920).
(14) Anderson, D B, and Kerr, T, *Ind Eng Chem* 30, 48 (1938).
(15) Sisson, W A, *Textile Research J* 7, 425 (1937).
(16) Conrad, C M, and Berkley, E E, *Textile Research J* 8, 341 (1938).
(17) Catlett, Mamie S, Giuffria, Ruth, Moore, Anna T, and Rollins, Mary L, *Textile Research J* 21, 880 (1951).
(18) von Bergen, W, and Krauss, W, *Textile Fiber Atlas* (1942).
(19) Compton, Jack, *Advances in Carbohydrate Chemistry* 3, 185 (1948).
(20) Gralen, N, and Svedberg, T, *Nature* 152, 625 (1943).
(21) Pacsu, E, and Hiller, L A, Jr, *Textile Research J* 16, 243 (1946).
(22) Nageli, C, *Die Staerkehoerner*, F, Schulthub Zurich, (1858); Nageli, C, Schwendener, S, *Das Mikroskop* 2, Aufl, W Englemann, Leipzig, (1877).
(23) Polanyi, M, *Naturwissenschaften* 9, 288 (1921).
(24) Katz, J R, *Cellulosechem* 6, 37 (1925).
(25) Meyer, K H, and Misch, L, *Helv Chem Acta* 20, 232 (1937).
(26) Mark, H, *Chem Rev* 26, 169 (1940).
(27) Sisson, W A, Monograph, *High Polymers* V, "Cellulose and Cellulose Derivatives". Interscience, New York, 215 (1943).
(28) Nickerson, R F, Monograph, *High Polymers* V, "Cellulose and Cellulose Derivatives". Interscience, New York, 1046 (1943).
(29) Farr, Wanda K, and Eckerson, Sophia H, *Contrib Boyce Thompson Inst* 6, 189 (1934).
(30) Nickerson, R F, and Habele, J A, *Ind Eng Chem* 39, 1507 (1947).
(31) Kinsinger, W G, and Hock, C W, *Ind Eng Chem* 40, 1711 (1948).
(32) Buck, George, *Textile Bull* 79, 59 (1953).
(33) Defore, Harry, Private Communication.
(34) Mercer, John, British Patent 13,296 (1850).
(35) Lowe, Horace, British Patent 20,314 (1889).
(36) de Chardonnet, Count Hilaire, British Patent 6,045 (1885).
(37) Schweizer, E, *J prakt Chem* 72, 109 (1857).
(38) Cross, C F, Bevan, E J, Beadle, C, *Ber* 26, 1090, 2524 (1893); 34, 1513 (1901); US Patent 520,770 (1894).
(39) Schutzenberger, P, *Compt rend* 61, 485 (1865).
(40) Miles, G, French Patent 358,079 (1905).
(41) Compton, Jack, Martin, W H, Word, B H, Jr. and Thompson, D D, *Textile Inds* 117, 138A (1953).
(42) Goldthwait, Charles F, McLaren, James and Voorhies, Samuel T, Jr, *Textile World* 96, 115 (1946); Cooper, A S, Voorhies, S T, Jr, Buras, E M, and Goldthwait, C F, *Textile Inds* 116, 97 (1952).
(43) Compton, Jack, *Ind Eng Chem* 31, 1250 (1939).
(44) Drisch, N, and Soep, L, *Textile Research J* 23, 513 (1953).
(45) Compton, Jack, US Patent 2,522,095
(46) Berkley, E E, *Textile Research J* 9, 355 (1939).

AATCC Committee on Stream Pollution——

CASE HISTORIES OF STREAM POLLUTION*

Western New England Subcommittee on Stream Pollution

I——Textile Effluent and a Sewage Plant

JOHN B DICK
The Pond Lily Co

IN the early 1940's when the New Haven Boulevard Disposal Plant was put into operation, difficulty was experienced in maintaining a satisfactory amount of residual chlorine in its effluent during the summer months when chlorination was required.

At those times when the raw sewage coming into the disposal plant was light-colored there was little or no trouble; but when it was dark-colored, the chlorine demand of the sewage increased greatly and could not be handled properly. The dark-colored influents usually started reaching the disposal plant in the early afternoon hours and continued in a very erratic manner until late in the evening.

As ours was the only dyeing plant on the sewer line, our effluent was suspected. After tests were made along the line, it was obvious that our wastes were responsible for some of the high-chlorine demands. It was also found that it took from 3 to 5 hours for our effluent to reach the treatment plant.

Our work consisted of bleaching, mercerizing, dyeing and finishing piece goods, chiefly all-cotton materials. Direct, sulfur, vat and naphthol colors were used, and practically all dyeing was done on jigs.

Considering the time lag, it seemed reasonable to suppose that the early afternoon difficulties at the disposal plant were caused by the spent liquors from the first set of jig dyeings and that the later troubles were tied up with the second and third sets of dyeings. This was borne out by subsequent tests. A great many samples of our wastes were collected by the Connecticut State Water Commission under the direction of their Willis J Snow. These were examined at Wesleyan University to determine chlorine demands and possible methods of treatment to minimize the difficulties at the disposal plant.

At the conclusion of the tests it was proposed that we attempt to segregate and hold our strong dye wastes during the day and to feed them slowly and uniformly into the sewer during the night hours when the domestic load at the disposal plant was the lightest. It was felt this would reduce the peak loads to such a degree that the plant could handle them successfully.

Two cement lagoons holding 22,000 gallons each were built, and additional waste trenches were installed in the jig room. By the use of two-way valves on each jig, we were able to divert our spent dye liquors and strong wash waters to the lagoons and our weaker wash waters, to the regular sewer. When the lagoons were emptied slowly from 7 PM to 6 AM, the disposal plant had comparatively little difficulty in operation.

As time went on, our capacity increased and also the quantity of spent liquors and wash waters. In 1951 we found that the wash waters from one of our pad-steam units was upsetting the disposal plant whenever this machine was used for dyeing dark sulfur colors. To take care of this, we built an additional lagoon of 33,000-gallon capacity and piped the first two wash boxes of this unit to the lagoons. We went through the 1952 chlorinating season with very little trouble.

We realize that few plants are situated as we are: emptying into sewers of a coastal city. Our procedure is outlined merely to show how our problem was handled.

II——History of Operations of Textile-Sewage Plants in Connecticut

WILLIS J SNOW
State Water Commission, State of Connecticut

The operation of two sewage plants for treatment of textile wastes is cited. A history of each plant and its operation are covered in a brief resume. The review is a statement of facts concerning the physical aspects of the treatment plants along with plant operations. The review includes observations of the problem from the point of view of management and the point of view of the sewage-plant operator and the results obtained in each case.

INTRODUCTION

WHEN the Beachdale Company, located at Voluntown, first started operations, it did kiering, bleaching and dyeing of cotton fabrics. Later it also prepared and dyed rayon fabrics. The liquid discharges from theses processes constituted the industrial wastes which required treatment before being run into the Pachaug River.

The company, without the approval of the State, first constructed a masonry and concrete basin, which it proposed to use as a plain sedimentation unit. This basin was approximately 30 feet long, 30 feet wide and had an average depth of about 3 feet. It was located at the outlet end of the mill's drainage line. Such a basin was inadequate as a sedimentation unit but it was later utilized as an equalizing basin and proved helpful in mixing the various waste liquors and in leveling out the strength of these liquors.

* These three case histories were prepared by members of the Stream-Pollution Subcommittee of the Western New England Section.

CONSTRUCTION OF TEXTILE SEWAGE PLANT

After consultation with the State Water Commission, the company installed a cylindrical wooden tank approximately 20 feet in diameter and 12 feet deep. Since it was never filled to the brim, its liquid capacity was in the neighborhood of 25,000 gallons. It was equipped with a central vertical shaft to which were attached, horizontally, long wooden paddles, to be used in stirring the chemically treated liquor. However, in actual operation these paddles caused the liquor to swirl around and around without becoming thoroughly mixed. Therefore, they were replaced with very short paddles, and, shortly afterwards, a vertical baffle was placed in the tank. These proved effective.

Through a hole at the bottom of the tank the settled sludge was drawn off by means of a pipe line provided for that purpose. The effluent pipe projected through the side of the tank, close to the bottom, and its inner end was equipped with a swivel-arm drawoff. The latter was an elbow and a piece of pipe about 2 feet long, joined loosely enough to permit the short piece of pipe to be raised or lowered by means of a long piece of ¾-inch pipe attached to its free end and reaching to the rim of the tank.

On a platform built at an elevation a little above that of the top of the settling tank were placed two 100-gallon cylindrical, wooden tanks, which were used as chemical-solution units. These were likewise equipped with mechanical stirrers and drawoff lines leading to the settling tank. One of these tanks was used for making a slurry of water and hydrated lime, and the other, for making an aqueous solution of ferrous sulfate (commonly called "copperas").

A corner of the equalizing basin was walled off and converted into a wet well, from which the waste liquors were pumped to the treatment tank.

The tanks and pumps were housed, and this building provided room for a limited amount of chemical storage.

By a relatively small amount of excavation and grading, three large, natural sand beds were provided for dewatering and drying the sludge.

An effluent trough, from the side of the building to the stream, was so constructed that it dropped like steps, thus affording considerable aeration of the discharged liquor.

Subsequently, a second settling tank of the same capacity as the first was erected outside but adjacent to the treatment building. It was similar to the first tank in all respects but one, namely, the mixing mechanism. In this second tank mixing was accomplished by means of air from a compressor, said air being introduced by means of perforated pipes laid on the bottom of the tank.

WATER-TREATMENT PROCEDURE

The treatment procedure was as follows: Waste liquors from the mill were gathered and intermingled in the equalizing basin. When a sufficient volume had accumulated, the pump was started and the equalized liquor was transferred to the settling tank. When the latter was about half full, the valve on the ferrous sulfate line was partly opened and this solution permitted to run slowly into the filling tank. The mixing device in the settling tank was also put into operation. As this continued a chemical floc could be seen forming in the liquor. It usually required about an hour to fill the settling tank. By the time it was full, the ferrous sulfate had all been added and the valve was then opened on the lime slurry line, stirring of the waste liquor continuing the while. Chemical dosage averaged about 1½ to 2½ pounds of ferrous sulfate and 1 to 1½ pounds of hydrated lime per 1000 gallons of waste liquor (dosage being varied according to the estimated strength of the liquor). When the lime was added, the floc became more dense and uniform. Tests were made with phenolphthalein to be sure that the treated wastes were on the alkaline side in order to ensure most satisfactory results.

When all of the chemicals had been added, mixing was stopped and the liquor was allowed to remain quiescent in order to permit the floc to settle to the bottom of the tank. The most favorable settling period seemed to be 2 hours or longer, although good results were often obtained at the end of 1½ hours.

At the end of the settling period the supernatant liquor was decanted and discharged into the nearby stream. It could be drawn down to within about an inch of the sludge layer by means of the swivel-arm drawoff mentioned above. This liquor was unusually clear and sparkling, free from any noticeable amount of solids or color and low in oxygen-consuming components. In other words, it placed no pollution load upon the stream.

After the supernatant liquor was drawn off, the sludge was discharged to the drying beds.

The emptying of the tank, including both clean liquor and sludge, required approximately one hour. This completed the treatment cycle and the settling tank was ready for another load.

After the second settling tank was installed, these units were used alternately, that is, one tank was filling and settling while the other was settling and emptying.

Occasionally the dried sludge cake was removed from the sand beds, carted away and used as fill. It dewatered at a reasonable rate and had no objectionable odor.

The entire system at that time produced very satisfactory results when properly operated.

OPERATING DIFFICULTIES ——— The main difficulties encountered were as follows:

1) Lack of conscientious effort on the part of the plant operator.

2) A tendency to short-cut treatments by not allowing sufficient settling time, etc.

3) Occasional chemical shortages because of poor planning or negligence.

4) Purchase of inferior grades of chemicals.

5) Pumping of waste liquors right through the settling tank without giving them any treatment.

As can be seen, none of these things indicate faults or inadequacies in the treatment plant itself but rather in the personnel responsible for its operation.

After the depression the Mill was being operated under a serious financial handicap. Because of a change and curtailment in operations, the volume and strength of the waste liquors had radically decreased. Consequently, in an effort to meet the competition of other mills, the company discontinued the treatment process and converted the sludge drying beds into large equalizing and seepage lagoons. The results were not entirely satisfactory, but the arrangement was tolerated in order to permit the mill to get back on its feet. However, it did not prosper and eventually was closed, and the treatment plant was allowed to deteriorate gradually.

A SIMILAR INSTALLATION

A similar treatment plant was installed at the former Ashland Cotton Company Mill at Jewett City.

Two cylindrical, wooden settling tanks were erected on a hill to the rear of the mill. They were approximately 10 feet in diameter and 20 feet tall and were not housed. They were not equipped with stirring devices, but instead the treatment chemicals were added to the liquor in the basement of the mill just before said liquor was pumped to the settling tanks. Both chemicals, namely, ferrous sulfate and hydrated lime, were added at the same time. The dosage was about the same as that at the Beachdale Company. It was assumed that the pumping of the chemically treated liquors provided sufficient mixing so that additional stirring was not necessary. Artificially constructed sludge-drying beds of limited area were located not far from the settling tanks.

Results were satisfactory so long as the treatment plant was given adequate attention. The system was dismantled when dyeing and finishing were discontinued.

III——History of a Plant for Treatment of Textile Sewage

A N HENSCHEL

INTRODUCTION

OUR purpose in this report is to describe in some detail the physical structure and operation of an intermittent type of chemical treatment plant operated for the rectification of high biochemical-oxygen-demand (BOD) wastes from a dyeing and finishing plant, in which mostly synthetic fabrics are processed involving only moderate alkalinity and smaller quantities of reducing agents than are ordinarily discharged from plants dyeing vat or sulfur colors.

GENERAL DESCRIPTION

The treating plant, for which details will be outlined in the next section, treats the waste of a dyeing and finishing plant that uses little alkali or reducing agents, such as are commonly found in the wastes of cotton finishing plants or print-works. Dilution of waste accounts for the minimum of solids being less than 1000 ppm; the maximum is limited by the nature of the chemical processing to about 2500 ppm. While much of the past experience, in sewage tests, has been based upon treatment with copperas and quicklime, continuing experiments and treatment would indicate that aluminum sulfate and quicklime are capable of producing highly desirable results especially in the removal of dye color. In brief, composites of waste color and chemicals are collected in a waste lagoon, and composite wastes are then pumped to the treatment tanks. Treatment from the time of starting may require 1 hour per 75,000 gallons with aeration to merely supplement gentle mixing. Settling starts immediately after aeration ceases and may be as short as 30 minutes. One hour is allowed before discharge is safely achieved, while 30 minutes is allowed for effluent discharge. A complete cycle may be as long as 2 hours and 30 minutes per 75,000 gallon tank, or, when both tanks are treated simultaneously, 150,000 gallons can be accomodated in approximately the same time with an extra allowance for time involved in manipulating valves.

Sampling of raw sewage and the treated effluent is performed by the operator. A technical operator on the day shift sets the treatment for the operators of the second and third shifts.

Limits of treatment are indicated, and costs as well as abnormal conditions are shown. In the literature it has been shown that shallow retention lagoons are desirable for raw-waste retention. It would appear, from practical considerations the larger the sewage retention basin the more uniform the waste and the easier the control of the treatment. While sludge collection and removal is carried out, means are being provided to minimize this by pumping sludge to dehydration areas for easier disposal. Mechanical equipment is elementary, but in a northern climate pump and mixing tanks for addition of chemicals must, of necessity, be housed in buildings with steam heat to keep pipes from freezing. Since the wastes received are hot, treatment tanks have not frozen in even the most severe winters of the last 14 years. Operation is carried on 24 hours per day, and only weekend plant-shut-down periods offer any hazard of freeze-up. The chemical cost will vary from $0.05 to $0.094 per 1000 gallons with maintainance and labor costs to be added, varying with the waste load.

OUTLINE OF DATA

CAPACITY

Volume of waste treated daily: 600,000 gallons, maximum.

Volume of water in each batch: 75,000 gallons.

Average solids: maximum in waste composite is about 2500 ppm; minimum average, about 763 ppm; total solids depends on dilution.

CHEMICALS FOR WASTE TREATMENT

Granular quicklime, commercial grade.

Aluminum sulfate hydrate, commercial grade.

Copperas (ferrous sulfate hydrate), commercial grade.

OPERATION OF PLANT

GENERAL STEPS——

1) Collection of waste (containing most of chemicals listed above) in primary retention lagoon of 200,000-gallon capacity.

2) Treatment in two separate 75,000-gallon tanks.

3) Effluent discharge of clean supernatant liquid to stream.

4) Sludge discharge to second sludge-collection lagoon.

OPERATION AND CYCLES——

1) Composite wastes from the plant are accumulated in the retention basin, or primary lagoon.

2) From the retention basin wastes are pumped into two 75,000-gallon treatment tanks. Each tank requires 30 minutes' pumping time to be filled.

3) Treatment in the form of chemicals dissolved in water is added simultaneously with the filling of the treatment tanks.

4) Aeration for 45 minutes is supplied by an electrically driven air compressor, which agitates the tanks separately, starting with the filling of the tanks.

5) Settling of the flocculant then proceeds for 45-60 minutes; and then the effluent is drawn off from the top of the treatment tanks by a jointed counterweighted discharge pipe, which is lowered as required.

6) After the clear supernatant liquid of the treated water is all drawn off, the remaining sludge is then discharged through a bottom drain to a trench leading into a sludge-collection lagoon, where, after complete settling takes place, the clear supernatant liquid is removed by an overflow pipe. Periodic removal of sludge from the lagoon is provided.

SAMPLING BEFORE AND AFTER——

1) Sampling for tests is made of com-

posite samples of raw industrial waste obtained at a point in the system located in a sump from which the sewage is pumped.

2) The discharge effluent is sampled at the point of discharge periodically during the day.

TESTING ——— Daily consumed-oxygen tests are made on the effluent discharge with the use of the American Public Health Association Standard. Check tests on the biological oxygen demand (BOD) of effluent are made periodically by the inspector of the State Department of Hygiene and Sanitation, and quality control is thus maintained.

Typical tests made on untreated sewage and treated sewage effluent for the oxygen consumed from permanganate are as follows:

TYPICAL TESTS OF OXYGEN CONSUMED FROM PERMANGANATE

Dates	*Before ppm*	*After ppm*
9/16	101	40-46
9/17	130	72-60-42
9/18	130	46
9/19	130	28-24
10/1	123	46
10/2	131	64-52-48-62-42
10/7	169	74-56-36-40
10/21	171	58-52
11/14	86-70	46-20
11/18	70	48
11/19	70	26-52
12/30	168	48-54
12/31	106	22
1/5/53	179	60
1/6	158	58
1/7	114	30

TOTAL CONSUMPTION OF CHEMICALS DURING EXPERIMENTAL PERIOD

Week	*Ferrous Sulfate*	*Lime*	*Alum*	*Ferrifloc*	*Gal Sewage*	*Cost/1000 gal*
	lb	*lb*	*lb*	*lb*		
1	2000	4,180			3,053,300	$0.030
2	2460	5,220			3,259,000	.039
3	1530	5,540	150	330	3,030,400	.042
4	2120	5,760	510		3,378,900	.041
5	1700	5,970	1500		3,022,200	.046
6	2900	6,120	600		2,904,400	.052
7	3400	6,400	250		2,842,900	.054
8	2800	6,180	700		2,945,100	.052
9	1700	6,240	1550		2,875,300	.058

DATA OF PHYSICAL PLANT

TREATMENT TANKS———Two cypress tanks, each 33 ft in diameter by 14 ft high. Capacity at overflow: 77,000 gallons. Open-top tanks are located out of doors.

SEWERAGE———Pipe line for sewage from lagoon to pump and from pump to over-the-top input into tanks is of 10- inch wrought iron.

PUMP———Centrifugal, low-pressure, high-capacity pump with 220-volt, 50-HP electric motor for drive.

AIR COMPRESSOR———Twin-cylinder, 5-HP air compressor, which delivers air at 75 lb/sq in through 1-inch line to bottom of each cypress tank with distribution through crossed pipes perforated at 12-inch intervals.

PUMP HOUSE———Steam-heated pump house.

MIXING PLANT AND CHEMICAL STORAGE ——— A steam-heated two-story building with interior lift of 1-ton capacity for bagged chemicals is used for storage of chemicals. Two 500-gallon chemical mixing tanks equipped with Lightning Mixers are provided for dissolving chemicals. The tank shells are made from ½-inch sheet steel. The building is designed especially to keep the lime storage dry.

PERSONNEL———*Daytime:* A technical operator to operate sewage-treatment plant, to make tests on all samples collected through a 24-hour period, and to set up proper treatment proportions for the following shifts. *Second shift:* An operator to pump and treat waste from lagoon. *Third shift:* The same as second shift.

In addition, a plant chemist must know how to operate the plant as well as the operators. A foreman of steamfitting and plumbing maintenance must be able to fill gaps in an emergency.

MISCELLANEOUS REQUIREMENTS ———Logs or records must be kept on each shift showing operating procedures and chemicals used. These form a basis of inventory supply records and consumption reports.

Operational procedures and desired treatments are posted on bulletin boards for convenience of operators. Charges of chemical ratios to be used are entered in the log and are also posted on a blackboard provided to show times and treatments for operators on successive shifts.

Testing of waste to obtain optimum proportions is accomplished by the technician by making up separate solutions of commercial grades of aluminum sulfate, copperas and quicklime in a concentration of 160 g/100 ml. Addition of 0.1 ml of any of these stock solutions to 100 ml of waste sewage will be equal to a treatment proportion of 1 lb of chemical to 1000 gallons of sewage. For convenience, quart Mason jars are used and filled with 800 ml of waste solution, treated, agitated 5 minutes at 15 rpm and allowed to settle. Obviously, composite samples of waste are best for empirical testing of this type. The proportion that gives the best flocculation, the quickest settling, and the clearest supernatant liquor is used for determining the treatment to be used. It has been found that when 50-100 lb of aluminum sulfate and 160-200 lb of lime are used uniform treatment for a 75,000-gallon batch of waste sewage can be maintained. When proper proportions for treatment have thus been established, we find we can hold the consumed oxygen below 50 ppm or lower. The supernatant effluent is clear and practically free of color. From tests such as those described above, the technician recommends the treatment quantities for the balance of the day.

CONCLUSION

It has been demonstrated that a plant for treating textile effluent can be run with acceptable results, ever with an eye to improvement and possible means of reducing costs. Although new detergents do offer problems because of built-in sequestering characteristics, it is believed that this type of plant is suitable to handle them.

It must be noted that State agencies offered valuable assistance in recommending studies of process methods in use at the plant. They called attention to the effect upon BOD of various chemicals used in the plant processes. Certain types of materials are believed to have profound effect upon BOD. Improved results are attainable through the simple process of a re-examination of plant formulations.

Delegates in attendance at last month's meeting of the Perkin Centennial General Committee.

Seated (l to r): Emil Ott, Society of Chemical Industry; L J Sheps, Canadian Association of Textile Colourists and Chemists; J Robert Bonnar, AATCC; R W Jacoby, Chairman of the Executive Committee; R C Swain, Manufacturing Chemists Association; E I Stearns, Inter-Society Color Council; R M Warren, American Chemical Society.

Standing: George H Schuler, Chairman of the Publicity Committee; W H Peacock, Society of the Plastics Industry; W George Parks, Chairman of the Educational Committee; H J White, Jr, Textile Research Institute; E R Allen, National Paint, Varnish & Lacquer Association; Ivar Ekholm, Technical Association of the Pulp and Paper Industry; Clyde D Marlatt, Dry Color Manufacturers Association.

Minutes of January 15, 1954 Meeting———Perkin Centennial General Committee

THE General Committee for the 1956 Perkin Centennial met on January 15, 1954 at the Waldorf-Astoria Hotel, New York, N Y.

The following items were discussed and decisions reached as indicated hereafter.

1. Registration fee

It was thought that there should be one registration fee to cover any part or all of the Perkin Centennial. As members of some of the participating societies might want to attend just one day's session, the fee should be kept at a point that would not discourage such attendance. It was thought that a maximum registration fee of $7.50 should be set which would include a book hereafter dscribed to cost not more than $2.50.

2. Committees

The following subcommittees of the General Committee should be organized: General Program, Dining and Banquet, Reservations and Registration, Reception, Publicity, Printing, Exhibits, Transportation, Educational and Ladies.

Each member of the General Committee is requested to advise R W Jacoby as to which of the above committees he feels most capable of becoming a member. It is logical that the activities of these committees might overlap; therefore, they should be clearly defined. Many of the delegates have had experience in the past and accordingly, they are asked to write in detail what they consider to be the duties of each of these committees. It is very vital that minor points be not overlooked. These various ideas will then be assembled and a composite list of duties will then be distributed to the various delegates.

3. Registration and Reservation

These will be handled by the New York Convention and Visitors Bureau. Each participating society will be requested to see that their members receive some form of application for reservation and registration. Each delegate should refer this matter to his own society so that plans will be made which will best fit into their methods of operation.

4. Luncheons, Dinners and Banquets

Any participating society can make arrangements for luncheons, dinners or banquets, but it is hoped that their plans will be such that anyone attending the Perkin Centennial will be eligible to attend the luncheon, dinner or banquet. The society sponsoring such an undertaking will make all of their arrangements with the hotel to decide upon the charges, etc. It was decided that all the reservations for such an event should be handled through the New York Convention and Visitors Bureau who would issue the tickets, collect the funds and turn same over to the sponsoring society. This will simplify matters rather than have reservations for banquets, luncheons or dinners going to several sources. There will be no registration fee for a person who simply attends any luncheon, dinner or banquet. The American Section of the Society of Chemical Industry is planning to hold its Perkin Medal Presentation Banquet on Friday evening, September 14, 1956. There will be no other activity of the Perkin Centennial that evening.

5. Commemorative Book

It was the first thought that a commemorative book should be prepared patterned after the 75 years of chemical progress book issued by the American Chemical Society on the occasion of their diamond jubilee. Experience with this book led the members of the General Committee to feel that such an idea would not be feasible. The point was brought up, however, that while all the papers presented at the Perkin Centennial will eventually be published in the official publication of the sponsoring society, the complete publication will cover a long period of time and in many instances, will not be too readily available to some people. Accordingly, it was decided that at the completion of the Perkin Centennial, all papers presented during the centennial be assembled and published in book form to be called "The Proceedings of the Perkin Centennial." Such a book would be mailed to each registrant when it is printed. The only complication would be whether any of the participating societies or authors would have any objection to their papers being included in these proceedings. Each delegate should take this matter up with his society.

6. Educational Committee

An Educational Committee will be formed whose duties it will be not only to enlist the cooperation and support of various educational institutions but also to develop a program for arousing interest in the field of chemistry as a career.

7. Open Meetings

It was thought that at least one open meeting should be arranged for where the public could attend without any registration fee.

8. Exhibits

Three rooms will be hired for exhibition purposes and there will be room for

(Concluded on Page P117)

REPORTS FROM THE LOCAL SECTIONS

Washington Section

THE Washington Section will meet on March 5th at the Textile Museum, 2320 S Street, N W, Washington 8, D C, at 8:15 pm to hear Louisa Bellinger, curator-analyst of the Museum, speak on the subject "Textiles of Antiquity."

Rhode Island Section

AT the January 28, 1954, meeting of the Rhode Island Section, held at the Providence (R I) Engineering Society, Henry E Millson, manager, Dyestuff Technical Service Laboratories, Calco Chemical Division, American Cyanamid Co, spoke on "Microscopical Dyeing Phenomena: Studies with the Microdyescope." The presentation was supplemented by slides.

Approximately 75 members attended the technical session and 40 members engaged in the pre-meeting social hour and dinner at the Sheraton-Biltmore Hotel.

The next meeting of the Section will be held on February 25th at Johnson's Grill, Providence, R I. Edward R Schwartz, head of the Massachusetts Institute of Technology's Textile Division, will present a paper entitled "Fiber Placement in Yarn and Fabric."

Respectfully submitted,
C F STOKES, *Secretary*

South Central Section

THE Fall meeting of the South Central Section was held at the Patten Hotel, Chattanooga, Tenn, on December 5, 1953, with more than 50 in attendance.

The afternoon technical session featured a talk by Sidney M Edelstein, Dexter Chemical Corporation, on "A Fresh Look at the Static Problem." He was assisted in his demonstrations and the discussion period by Newton A Teixeira, Fabric Research Laboratories.

At the evening banquet and business session a report and comments on the 1954 Convention were made. The following officers were elected for 1954:

Chairman — PAUL O ANDERSON, Peerless Woolen Mills

Vice-Chairman — JOE T BOHANNON, JR, American Aniline Products, Inc

Secretary — WILLIAM F LUTHER, Dixie Mercerizing Co

Treasurer — J C WHITT, Standard-Coosa-Thatcher Co

Councilor — J D MOSHEIM, Crystal Springs Bleachery

Ray B Slagle, Aetna Life Insurance Co, served as banquet speaker.

Respectfully submitted,
JOE T BOHANNON, JR, *Secretary*

Harry L Morgan, James Lees & Sons Co (right) congratulates Frederick V Traut, Globe Dye Works, on the latter's recent assumption of the Chairmanship of the Philadelphia Section.

Philadelphia Section

THE first meeting of the 1954 season of the Philadelphia Section was held on January 15 at Kugler's Restaurant, Philadelphia, Pa.

The new chairman, F V Traut, Globe Dye Works, represented the Section in presenting retiring chairman Harry L Morgan, James Lees & Sons, with a watch in recognition of his service.

Mr Traut introduced the officers, councilors and committee chairman for 1954. (These were as noted in the December 4th meeting report except that Henry J Rotters, Artloom Carpet Co Inc has replaced J W MacNeil, Althouse Chemical Co, on the Sectional Committee and Thomas R Scanlan, Jr, Hart Products Corp, has replaced Mr MacNeil as Publicity Chairman.)

Program Chairman C T Anderson, Ciba Co, Inc, introduced Virgil T Hartquist, Jefferies Processors, who presented the Section's 1953 Intersectional Contest paper, "Leveling Unevenly Dyed Materials."

Approximately 145 members and guests were present.

The next meeting of the Section will be February 26 at Kugler's.

Respectfully submitted,
THOMAS J SCANLON, *Secretary*

* * *

THE Philadelphia Section's Committee on Stream Pollution held its initial meeting on January 19, 1954 at the Philadelphia Textile Institute.

Committee Chairman Thomas H Hart, Hart Products Corporation, opened the meeting and introduced Bertrand Hayward, PTI director; George Wunsch, North American Lace Co, Committee Vice Chairman, and Alfred W Cowan, Ankokas Dyeing & Processing Co, Committee Secretary. Mr Hart then outlined the progress to date regarding the function of the National Committee on Stream Pollution.

Percival Theel, a member of the National Technical Task Committee of the U S Public Health Service, gave a report on a meeting of that Committee held in Cincinnati, Ohio, January 14, 1954.

Following Prof Theel's report, Mr Hart introduced Dr R Heidorn of Hungerford & Terry, Inc, who delivered the principal talk of the evening. During his presentation, he cited five case histories of sewage disposal problems.

Following the paper, future plans for the activities of the Committee were discussed. It was decided that the Committee would accumulate data on the laws and regulations of the 48 States. The Committee agreed to volunteer its cooperation for the preparation of a Textile Trade Waste Manual, which will be written through the auspices of the National Committee on Stream Pollution.

George A Elias, District Engineer of the Pennsylvania Department of Health, congratulated the Committee on its organization and offered his cooperation wherever possible.

There were approximately 25 members and guests in attendance.

Perkin Centennial General Committee Meeting

(Concluded from Page P116)

between 50 and 75 booths. The cost of these rooms for the duration of the centennial will be a very considerable item and, therefore, must be revenue producing. Under these conditions, complimentary booths would not be available to participating societies.

9. Budget

When all of the subcommittees have been appointed and their duties clearly defined, each committee will then be asked to submit a budget for their activities to the general finance committee.

10. Program Topics

It was decided to change the program topic to "The Application of Colorants" in view of the fact that pigments as well as dyes will be included.

All delegates are invited to submit any ideas they may have in connection with the Perkin Centennial.

NOTICE TO AUTHORS OF PAPERS

MANUSCRIPTS for the *Proceedings* and for other publications of the American Association of Textile Chemists and Colorists shall conform to the requirements and standards given in this *Notice*. Before publication, manuscripts for the *Proceedings* shall be approved by the Editor, not only for editorial correctness according to the standards of this *Notice*, but also for content of technical matter. In his work, the Editor may enlist the aid of anonymous reviewers who are selected for expert knowledge in particular fields.

It is presumed that authors in studying the comments of reviewers and of the Editor will remember that all recommendations are made in a kindly, helpful, sympathetic manner to improve the paper in both literary and technical excellence. Although authors should cheerfully consider suggestions, they are expected to defend their position if justified, especially when strictly technical matters are involved with which the authors have an intimate knowledge.

MANUSCRIPTS—Manuscripts shall be typewritten double-spaced with approximately one-inch margins on 8.5 x 11-inch white paper. In addition to the *original*, at least one carbon copy is required. Pages are to be numbered consecutively with Arabic numerals, and each page after the first shall carry the authorship at the very top. Tables and figures shall also be numbered consecutively, the tables with headings containing Roman numerals as TABLE I, TABLE II, etc, and the figures with Arabic numerals as Figure 1, Figure 2, etc, appearing *below* the figures. The names of the authors and their laboratories or business connections should appear below the title of the paper.

ARTICLES APPEARING IN THE "PROCEEDINGS" IN RECENT ISSUES OF THE "AMERICAN DYESTUFF REPORTER" will be helpful to authors as models of form for the typing of manuscripts.

LITERARY STYLE AND FORM OF PRESENTATION—In the writing of papers, authors are requested to observe a trenchant, simple style of writing directed to textile chemists and colorists with at least an elementary knowledge of chemistry, physics, mathematics, engineering, textile processes and textile machinery.

In the organization of the material, there should be one or more introductory paragraphs setting forth the occasion, significance and main objectives of the paper and of the method of attack. This should be followed by the body of the presentation, either with discussions interspersed throughout this portion or with a collected section marked "DISCUSSION" after the main body of the paper. Finally, there may be a brief section at the end entitled "SUMMARY" of "CONCLUSIONS."

Center and side headings make for easier reading. Center headings should be employed sparingly and generally will include only very important section headings, such as "INTRODUCTION," "EXPERIMENTAL," "DISCUSSION," "CONCLUSIONS," "SUMMARY," and "REFERENCES." Side headings (see third paragraph of this *Notice* for an example) shall be indented and run into the text to which they apply, and shall be separated from the paragrpah by a dash. The publisher will print center headings in bold-face capitals and side headings in capitals.

LITERATURE REFERENCES AND FOOTNOTES—References to the literature and all footnotes (except those in tables) shall be numbered consecutively with underlined Arabic numerals in parentheses at the proper place in the text. Where a reference or footnote is to be used again, the original number is simply repeated; this obviates the necessity of repeating the footnote or reference at the bottom of the page. References to the literature shall conform to the universal usages followed by *Chemical Abstracts*, which include underlining of book and journal names to indicate italicization in printing.

The spelling and rules of punctuation followed in manuscripts shall be those found in the *Merriam-Webster New International Dictionary;* abbreviations and chemical formulas shall conform to *Chemical Abstracts*. Periods shall be used only at the end of sentences, not after abbreviations.

FIGURES AND GRAPHS—Figures and graphs should be black line drawings on white drawing paper. Photographic prints are acceptable, preferably glossy prints on double-weight paper. Duplicates should be available for dispatch to reviewers. Diagrams and graphs should preferably be designed in long form to cover one column of print but may be two columns wide or the width of a full page where necessary. In graphs the frame and actual curves should be inked more heavily than the co-ordinate lines, and these latter should not be too close together. Various styles of broken lines are sometimes desirable to distinguish curves. Experimental points should be given with small plane figures, such as circles, squares, diamonds or triangles. Numbers and legends on co-ordinate axes are to be lettered in the graph by the author. Numbers and titles of figures should be placed below the diagram or on the edge of the back. Each piece of illustration copy should bear on the margin or on the edge of the back the name of the author and the title of the paper.

Photographs of authors should be included with copy, to be run in conjunction with the paper. These must be on glossy stock, and should be large enough for proper reproduction.

TABLES—Tables should not be used indiscriminately because they are very expensive to set up in type. They should be designed to be one column, two columns or three columns wide. Tables should be arranged with the view of conserving space; column headings should be short and abbreviated. Quantity designations shall never appear in the body of the table but in the headings. Tables, if possible, should be placed in the manuscript where they belong rather than separately.

SYNOPSIS—A separately written synopsis of not over 200 words containing the gist of the subject matter must accompany every manuscript.

GALLEY PROOFS—Galley proofs will be sent to the author by the publisher for correction before publication. This should not be interpreted as an invitation to rewrite the paper but rather as an opportunity to correct errors.

REPRINTS—Fifty reprints of papers published in the *Proceedings* will be furnished without charge by the publisher if requested when galley proofs are returned. These reprints are printed on one side of the sheet only and then stapled together. A schedule of prices of reprints in the usual form accompanies the galley proofs.

OWNERSHIP OF COPYRIGHTS AND PATENTS—All papers presented at general meetings of the Association or at meetings of any of its local sections and all communications shall become the property of the Association. Such papers are not to be published elsewhere until they have appeared in the *Proceedings* of the Association. Papers published in the *Proceedings* are copyrighted by the Association. Any patentable disclosures shall of course remain the property of the author or authors.

TRADE-MARKS — As the AATCC wishes to co-operate in the protection of trade-marks, it is requested that, in the body of the article, trade-mark names be written with an initial capital letter. Courtesy demands that authors include competitive products as well as those of his firm. Many current trade-mark names are to be found in the *AATCC Technical Manual and Yearbook*.

HISTORICAL NOTES ON THE WET-PROCESSING INDUSTRY

II—A Look at the Early Dyers' Guilds

SIDNEY M EDELSTEIN
Dexter Chemical Corporation

This is the second in a series of historical articles which the textile chemist and colorist will find of interest.

The author, a prominent science historian, is the founder of an outstanding collection of great works, documents and letters in the history of chemistry and related sciences.

Articles and illustrations in this series are from the author's library.

TODAY if a man wishes to become a dyer he must depend mainly on his own training and ability. He may be a good dyer or a poor one; he may have many years of training and scientific education or practically none. But in any case he does not need the official approval of his fellow dyers or of any organization. Up until recent times things were quite different.

Last year, there appeared in a European rare book catalogue the following short listing, "Item 1197, Meister-brief f Einen Farber. Stadt Eltsch, Oesterreich, 1 mai 1800." This obviously referred to an official document from a dyers' guild—a rare and unexpected thing. The item was ordered and after a period of many months it arrived. Happily it turned out to be a rare and beautiful example of an official guild diploma permitting two men, Andre Hermannofs and Johann Garsoff, to be master dyers with the approval and guarantee of their fellow craftsmen. A photograph of this document is shown in Fig 1 and a free translation is herewith presented:

"We, the assembled supreme elders and master craftsmen of the honorable national guild, whose imperial and royal prerogatives have privileged the dyers of fine blacks and blues and also the master craftsmen of the press and calender, in the favored mountain town of Eltsch in Goemoerer and Kis-Hont, to unite in committee, herein- attest and certify: as a demonstration of this gentleman———befittingly entreats us to elect him a member among the number of our guild. If now among our collected group there is nothing adverse known about him: he also has the power and imperial and royal commission to manufacture the masterpiece, and the same shall be recognized as authentic; we have, as of today, accepted and embraced the above mentioned gentleman ——— as a worthy fellow master craftsman in our society. Let us extend then to all our business associates in the fine black dye industries, a friendly request, to recognize the same worthy, most respected gentleman——— as a member of our honorable guild, and you should see to it that this same person is given a full measure of endorsement. We, unconditionally, stand ready and willing to reaffirm the above statement. As a result of our infallible confidence in the above, we have confirmed our testimonial with our corporation seal. Eltsch, May 1, 1800.

Supreme Elder—Michael Taichengraben
Recipients—Andre Hermannofs, Johann Garsoff

In the Middle Ages people formed associations of many kinds almost as frequently as we do today. Some of these associations were called guilds, the best known guilds being societies of merchants and workmen, but there were also many social, military and religious groups.

Because of transportation and communication difficulties these associations or guilds were local affairs. Dyers' guilds usually were made up of all the town's dyers who shared a particular facet of the dyeing trade. In some towns the dyers' guilds included dyers of all colors in all degrees of fastness. In other towns there were several dyers' guilds, each guild including only those dyers working with specific colors, such as blue and blacks, or with specific fibers, such as silk or wool. The members of each guild were divided into three classifications. At the top were the masters who alone had the right to buy raw materials and sell finished products. The second class was made up of journeymen who received wages from the masters for performing the important dyeing operations. The apprentices made up the third class and they only received board, lodging and training. The climb from apprentice to journeyman and finally to master was long and slow. Before a person could finally become a master he had to complete a masterpiece, which was some unusual or difficult piece of dyeing and he also had to have enough money to set himself up.

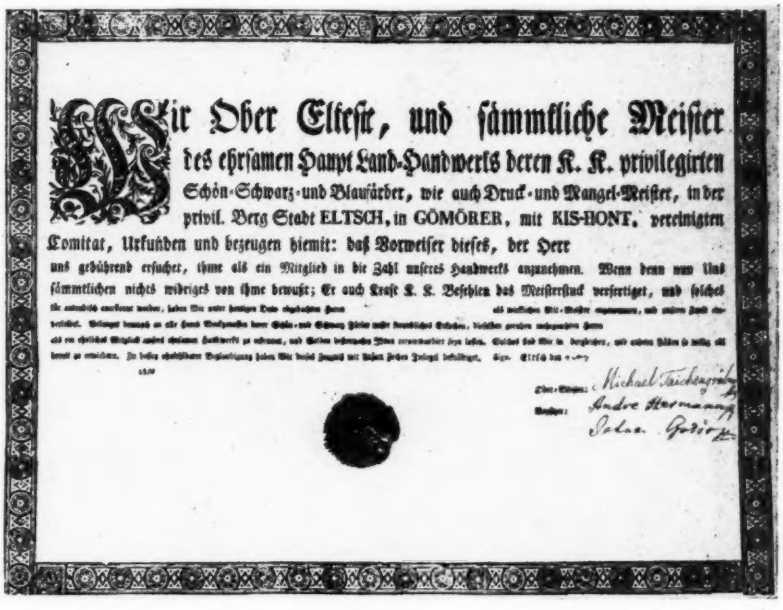

Wir Ober Elteſte, und ſämmtliche Meiſter
des ehrſamen Hanpt Land-Handwerks deren K. K. privilegirten
Schön-Schwarz-und Blawärber, wie auch Druck-und Mangel-Meiſter, in der
privil. Berg Stadt ELTSCH, in GÖMÖRER, mit KIS-HONT, vereinigten
Comitat, Urkunden und bezeugen hiemit: daß Vorweiſer dieſes, der Herr
uns gebührend erſuchet, ihme als ein Mitglied in die Zahl unſeres Handwerks anzunehmen. Wenn denn nun Uns
ſämmtlichen nichts widriges von ihme bewußt; Er auch Kraft L. L. Befehlen das Meiſterſtuck verfertiget, und ſolches
Michael Taichengrab
Andre Hermannofs
Johan. Garsoff

Figure 1

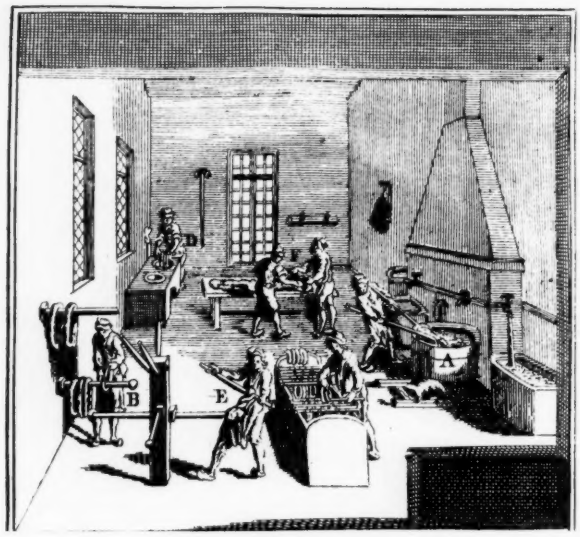


Figure 2

A representation of the inside of a silk dyers' dyehouse with the different operations; A—The workman taking the sacks or pockets, in which the silk had been boiled, out of the great copper; B—The workman dressing the skeins on the peg; C—The dyer dipping the silk in the great trough; D—The workman dipping in the vat; E—The workman who dry-wrings on the peg; F—Two men pocketing the silk for boiling.

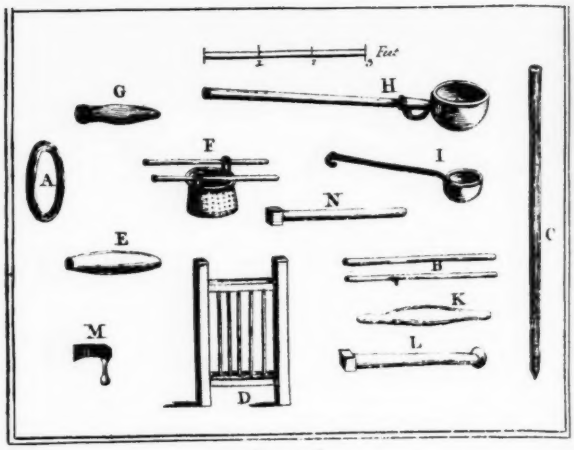


Figure 3

A—A skein of silk; B—Rods on which the hanks are passed in order to be dyed; C—Perch or barr for turning the pockets containing the silk, whilst boiling, and for taking them out of the copper; D—A kind of barrow on which the wet silks are laid; E—Rod on which the hank of silk is put for dipping in the vat; F—Rocou pot of cullender used for dissolving this ingredient; G—A kind of pestle used for bruising the rocou and passing it through the cullender; H—A large copper ladle; I—A small ladle; K—Pin used for wringing on the peg; L—Peg; M—Hatchet for chopping the dyeing woods; N—A pin or peg.

(The phraseology of the captions for figures 2 and 3 is retained from the book "The Art of Dyeing Wool, Silk and Cotton")

The dyers' guild survived through the 18th century and a few were still in existence in isolated towns in the 19th century. Towards the end of the 18th century many towns and countries began licensing arrangements for dyers in concert with the guilds and gradually in many cases took over the work of the guilds.

Undoubtedly the guilds served a useful purpose for the most part both for the dyers and for the consumers of dyed fabrics, but in many cases gross injustices prevented skilled dyers from reaching the top position. Today our own scientific and trade associations are making use of many of the good traditions of the old dyers' guild.

BOOK REVIEWS

NEUE VERFAHREN IN DER TECHNIK DER CHEMISCHEN VEREDLUNG DER TEXTILFASERN

(Volume II of Part II —— Neueste Fortschritte und Verfahren in der chemischen Technologie der Textilfasern)

Louis Diserens
Verlag Birkhäuser
Basle, Switzerland
118.50 Swiss francs; 900 pp

Each part of Dr Diserens' monumental work consists of three volumes. The three volumes of Part I cover the processes and auxiliaries employed in the application of dyestuffs to textiles, the major portions of which have been translated into English. Part II, of which this is the second volume, comprises a compendium of finishing methods and materials. (Volume III is to follow).

This particular volume is devoted to a complete and systematic coverage of thickening agents for printing and finishing, synthetic resins of all types including modified celluloses and latices, also silicones, oils and waxes. A considerable portion of the book reviews the broad field of anionic, cationic and nonionic surface-active agents and other washing and finishing compounds and emulsions from modified natural rosins. There is, further, a general discussion of chemicals used in finishing, including optical bleaches, antistatic agents, and moth- and mildew-proofing products.

Each chapter contains a tabular review of proprietary products arranged in listings of competitive groups. A generous number of American-manufactured products are included. Patent numbers are cited for most synthetic products and processes, and cross indices permit references to other volumes where the same patents are mentioned.

This, the fifth in the series of six volumes, is a logical and important portion of the tremendous canvas. It should prove especially valuable to chemists interested in the production and use of auxiliaries and surface active agents for the textile industry. When complete, the Diserens' volumes will constitute the chemist's encyclopedia of the science of finishing in the broadest sense of the word.—HPB

ORGANIC SYNTHESES—— AN ANNUAL PUBLICATION OF SATISFACTORY METHODS FOR THE PREPARATION OF ORGANIC CHEMICALS (VOLUME 32)

Richard T Arnold, Editor-in-chief
John Wiley and Sons, Inc
New York, N Y
$3.50; vi + 119

This book, number 32 in the valuable series on organic preparations, represents a collection of procedures which may be of general interest, or which illustrate useful synthetic procedures. The procedures are submitted by individual chemists. The work published is corroborated by full data concerning the range of yields obtainable, the melting point of the solid given, and the boiling point and refractive index (25°C) of each liquid product. The method of preparation of some of the reactants, and the criteria for the purity of the product is stated. At the end of each procedure notes are included by which a greater clarity or emphasis may be obtained. In addition references are also included to serve the reader more fully.—VL.

NEWS

W R Howell

• Howell Elected to NAFTF Presidency at 40th Annual Meeting

Walter R Howell, executive vice president of Bradford Dyeing Association (USA), was elected president of the National Association of Finishers of Textile Fabrics at that Society's 40th Annual Meeting in New York last month. Mr. Howell succeeded Sydney M Cone, Jr, Cone Finishing Company, who had completed a 2-year tenure of office.

The retiring president, Mr Cone, in his annual report voiced optimism about the finishing industry's 1954 volume but stated that prices are bound to be very competitive. He also noted that washable fabrics are in greater demand today than ever before and fabrics which reduce the home launderer's problems and labor will meet increasing favor.

Reviewing the Association's work in the past year, Mr Cone noted especially its efforts on the Flammable Fabrics Act problem, waste disposal legislation, color classification, water repellent trade practice rules, and a survey of textile printing machines.

Arthur G Poor, Standard Bleachery & Printing Company, retiring chairman of the Executive Committee, was presented with an engraved silver tray in recognition of his service to the Association and the industry. He has served two years as president and two years as Chairman of the Board.

A luncheon in the Starlight Roof followed the business session and the members heard the guest speaker, Eddy Gilmore, former Associated Press Moscow Bureau Chief, describe conditions inside the Soviet Union.

Elections were held during the morning session and in addition to Mr Howell, the following officers and members of the Executive Committee were elected: Chairman of executive committee, Sydney M Cone, Jr, Cone Finishing Company; vice presidents, J Marshall Cole, Cold Spring Bleachery and George Sinkinson, Sayles Finishing Plants.

The following members were elected to the Executive Committee: Robert Amory, Springs Mills (Grace Bleachery); Robert Bendheim, Rock Hill Printing and Finishing Company; E R Farrell, Mansfield Bleachery; W O Forssell, Slatersville Finishing Company; James Harrell, J P Stevens Company (Delta Finishing Company Division); C Scott Lewis, Fairforest Company (Finishing Division); Lawrence Marx, Jr, Clearwater Finishing Company; Royce N Pharr, United States Finishing Company; William Reid, Riegel Textile Corporation; Chas N Robertson, III, Robertson Bleachery & Dye Works; Julian Robertson, North Carolina Finishing Company; G S Rockefeller, Cranston Print Works; John Ward, Bellman Brook Bleachery; C B Hayes, Pacific Mills (Lyman Division); and A L Garfinkel, Lowell Bleachery, Inc.

In addition to the above, the following members of the Executive Committee continue to serve unexpired terms as follows: Arthur G Poor; W R MacIntyre, Jos Bancroft & Sons Company; G D Harrison, Pepperell Mfg Company (Lewiston Division).

• New GDC Branch Opened in Chattanooga

Executives of General Aniline & Film Corporation and General Dyestuff Corporation travelled to Chattanooga, Tennessee on January 29th to participate in the formal opening of a new branch building erected to service the dye and chemical business in the area.

H A Webb

The new building, located at 4301 Rossville Boulevard, houses office, warehouse and laboratory facilities for General Dyestuff Corporation and Antara Chemicals, sales divisions of General Aniline. The building is air-conditioned throughout and is electrically heated. Warehouse space covers about 17,500 square feet.

The GAF-GDC executives, headed by senior vice president John H Hilldring and Sumner H Williams, vice president and general sales manager, joined with more than 100 customers in an inspection tour of the building. An informal dinner followed the plant visit at Lookout Mountain Fairyland Club in Chattanooga.

H A Webb, whose appointment as branch manager was announced by Mr Williams coincident with the opening of the new building, served as host. Mr Webb first joined GDC in 1935 as a laboratory assistant at the Charlotte, N C, branch. Appointed with Mr Webb, as office manager, was W R Criminger, who had been employed at the Charlotte branch since 1940.

The new office will service Tennessee, Alabama, Arkansas, Louisiana, Mississippi, Texas and parts of Florida, Georgia and Virginia.

The new Chattanooga branch of General Dyestuff Corporation.

• Pittsburgh Coke & Chemical Acquires Carolina Site

Pittsburgh Coke & Chemical Co, Pittsburgh, Pa, is beginning immediate construction of a modern building for its Fine Chemicals Division on a newly acquired 150-acre site at Spartanburg, S C. The Division presently manufactures a broad line of vat dyestuffs at their basic manufacturing plant in Pittsburgh. This is supplemented by research and customer service laboratories in Pittsburgh as well as sales and warehouse facilities in Providence, Philadelphia and Charlotte.

The facilities at Spartanburg, as part of a long range industrial development study on the part of the Company to establish the advantages of manufacturing dyestuffs and other chemical products in that area in the future, will include a completely equipped service laboratory with a full staff of chemists and technicians. Richard M Locke, sales manager for the Fine Chemicals Division will supervise the new facilities.

The establishment of Pittsburgh Coke & Chemical Company in Spartanburg, along with the company's general expansion in chemical product activities during the past several years, is being directed by W K Menke. Mr Menke states that Spartanburg was chosen for the site of the company's new southern facilities largely because of the area's natural advantages, including its excellent marketing location, transportation facilities, availability of utility service and the cooperation of local groups in the undertaking.

• Cotton Canvas Goods Research Fellowship Established in USDA

An industry fellowship for research on cotton textiles has been established by the National Canvas Goods Manufacturers Association at USDA's Southern Regional Research Laboratory in New Orleans, the object of which is to improve cotton for outdoor use.

The purpose of the fellowship is to conduct investigations aimed at improving the performance of canvas goods and sewing thread in awnings, tents, and tarpaulins — important outlets for cotton. The experimental work will be integrated into the Southern Laboratory's broad program of research to maintain and extend the utilization of cotton.

The Association has appointed John V Bailey to conduct the work of the Fellowship. Mr Bailey will work under the general direction of W Norbert Berard, chemical technologist in the Cotton Chemical Processing Division of the Southern Laboratory.

Upper photo: Sales Symposium, Hart Products Corp.

Lower photo: A view of Hart Products Corporation's newly expanded laboratory at Jersey City, N J.

• Hart Products Sponsors Symposium at Expanded Laboratory

The Hart Products Corp, New York, was host to a technical and sales symposium recently at the company's newly-expanded laboratory in Jersey City, with talks and meeting continued at the Hotel Statler, New York. The meetings in Jersey City were given over to a group of papers on technical subjects, followed by documentation and discussion. The principal guest speaker, Fred Fortress, research section head, Celanese Corporation of America, spoke on the subject of acetate finishes. Participating in the Symposium were E I Birnbaum, treasurer, and Harry Zimmerman, director of research, Hart Products Company of Canada, Ltd; and S Cohen, research chemist, Morris B Hart, secretary, and B Robert Schwartz, chief chemist, Hart Products Corporation.

Other speakers during the Symposium were John Helwig, chemical analyst, Hart Products Company of Canada, Ltd, who presented a paper on "Products Evaluation Control." Ralph Hart, president of the company, greeted the 25 guests and participants, while Dr Schwartz acted as chairman and Mr Birnbaum introduced the speakers. A dinner and theatre party were held as a conclusion to the symposium, with Hart Products Corporation acting as host.

In announcing the addition of $50,000 worth of new equipment to the half-million-dollar plant and laboratory at Jersey City recently, Dr Schwartz pointed out that the new installations include electrostatic measurement devices, laboratory colloid mills, gas-fading equipment, an ultrasonic homogenizer, wrinkle testers, a hydrostatic absorption meter, and considerable pilot plant equipment. As well as performing basic research work, the laboratory is now conducting special experiments in the areas of antistatic agents, permanent water repellents, organic sequestering agents, and ethylene oxide condensates. The research efforts at Jersey City are coordinated with those of the Hart Products Company of Canada, Ltd, supervised by Mr Birnbaum.

• Cranston Moves Uptown

The Cranston Print Works Company has leased the entire 28th floor in the building being completed at 261 Madison Avenue, New York, and will move its metropolitan sales office there when the building is ready, according to an announcement by Godfrey Rockefeller, president.

It is expected that the move will actually be made early in the Spring.

• New Fibers Laboratory in Operation

Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation, has announced the beginning of full-scale operation of a new laboratory building for the study of synthetic fibers.

The laboratories, located at Carbide's Research Center in South Charleston, W Va, are equipped with facilities for the preparation and evaluation of films of experimental resins; the small scale preparation of fibers by wet-spinning, dry-spinning and melt-extrusion; detailed studies of such operations as stretching, annealing, drying, cutting; evaluation of fibers in knitted and woven fabrics; basic research on dyeing, and systematic studies of the fundamental properties of fibers. The facilities include air-conditioning equipment which is said to be capable of providing controlled temperatures and humidities over an unusually wide range.

• Consolidated Chemical Moves N Y Office

Consolidated Chemical Industries, Inc, has moved its New York offices from 630 Fifth Avenue to 380 Madison Avenue, effective February 1st. The new telephone number is OXford 7-1340.

• Young Chemists Meet

The annual Young Chemists Meeting of the New York Section of the American Institute of Chemists was held on Thursday, January 7, at the Jacob Ruppert Brewery, New York.

Speaker for the evening was Prof Benjamin Harrow, chairman of the Department of Chemistry of the College of the City of New York, who spoke on "Exploring the Frontiers of Chemistry."

This meeting is designed to afford young chemists just embarking on their professional careers an opportunity to meet other chemists and to learn of the activities of the American Institute of Chemists.

• Celanese Fellowship Program

The graduate fellowship program of Celanese Corporation of America for the 1953-54 academic year embraces 20 fellowships in 17 different colleges and universities. The program covers a wide range of activity, including those sciences of particular interest to the various phases of Celanese operations.

In general, each fellowship is for a one-year period, but provision is made for a continuation of study for an additional year when required. The fields of study include textiles and plastics; cellulose, organic, physical and general chemistry; chemical and mechanical engineering; and physics.

Fellowships under the program have been established at the following colleges and universities: Clemson; Cornell; Georgia Tech; Harvard; Illinois; Louisiana State; Lowell Tech; McGill (Canada); North Carolina State; Oklahoma; Princeton; Rice; Stevens; Syracuse; Texas; Wellesley and Wisconsin.

NAMES IN THE NEWS

R J Mitchell

RAYMOND J MITCHELL has been named manager and ARTHUR A BARKER, technical supervisor, of the Cincinnati Branch, Sandoz Chemical Works, Inc.

Mr Mitchell went with Sandoz in 1940 and was assigned to the Providence office. Previously he had served as assistant dyer at Lippitt Worsted and superintendent of dyeing at Brunswick Worsted.

THE Sylvania Division, American Viscose Corporation has announced the employment of ROBERT P THORNTON at the Boston Sales office. His territory is South Massachusetts, Rhode Island and part of Boston.

Mr Thornton was formerly employed with Pillsbury Mills, Inc for 3½ years.

OBITUARY

JACQUES P WOLF

JACQUES PHILLIP WOLF, founder and president of Jacques Wolf & Co, died January 26, 1954 at his Montclair, N J home after several years' illness.

Born in Muhlouse, France in 1873, Jacques Wolf was the son of Jacques and Angelique Golder Wolf. He was educated in France and came to the United States in 1901, at the age of 28.

Wolf began his career in the chemical business with a partner, Abran De Ronde in the basement of an old Passaic whip factory. The original firm name. Wolf & De Ronde, was later changed to Jacques Wolf & Co. Under his leadership, the company grew from a basement business to its present world-wide operation with plants in Clifton, Passaic, Carlstadt and Los Angeles, and with an extensive export trade to all parts of the globe.

Although an invalid for several years, Mr Wolf was in constant touch with the business and kept a portable laboratory in his Montclair apartment for experimentation. Surviving is a cousin, Miss Marthe Fischesser of Mountain Lakes, N J.

H B Childers

HERMAN B CHILDERS has been appointed technical sales representative of Amalgamated Chemical Corporation for the Virginia-Carolina section. Mr Childers, who will assist Robert A Bruce, Vice President, will make the southern office in Greensboro his headquarters, calling principally upon the hosiery industry.

Born and educated in the south, Mr Childers acquired extensive experience in dyeing and finishing of full-fashioned as well as half-hose with concerns such as Nebel Knitting Company and Commonwealth Hosiery Mills.

ROBERT H HELLE has been named administrative assistant to the director of research, The Chemstrand Corporation, Decatur, Ala. Prior to this latest assignment, Mr Helle was technical superintendent of Chemstrand's Acrilan acrylic fiber manufacturing plant.

THE following slate of officers has been chosen to head the New York Pigment Club for 1954:

President — AARON PERMUT, Aula Chemicals, Inc

Vice President — ROBERT J O'BRIEN, Collway Colors, Inc

Secretary — EMIL A WICH, General Dyestuff Corp

Treasurer — HANS A KAHN, Max Marx Color & Chemical Co

Board of Governors — JUSTIN B ARNOLD, Paul Uhlich & Co, Inc; JOHN DONAHUE, Fine Colors Co; HERBERT JOHNSON, H Kohnstamm & Co, Inc; CHARLES H LOVE, C K Williams & Co; JOHN SHOWN, General Aniline & Film Corp; CASPER SMITH, Smith Chemical & Color Co.

THE Textile Section of the New York Board of Trade last month named CAMERON A BAKER chairman for the coming year. Mr Baker, a research engineer with the United States Testing Company, succeeds WINSTON L MAY, JR, vice president of Chicopee Mills, Inc.

Other officers elected were:

Vice Chairman — HENRY C HOOFMANN, Reeves Bros, Inc

Treasurer — WILLIAM C BATCHELDER, National Credit Office

Executive Secretary — CHARLES J Murphy

DARRELL E KNOX, J W Valentine Co, was appointed as the Textile Section representative to the Board of Directors of the NYBT.

THE appointment of CORTEZ P HACKETT to the post of director of development, Solvay Process Division, Allied Chemical & Dye Corporation, became effective on February 1st. Mr Hackett succeeds D O YEOMAN, who retired January 31st after approximately 41 years service with the Company.

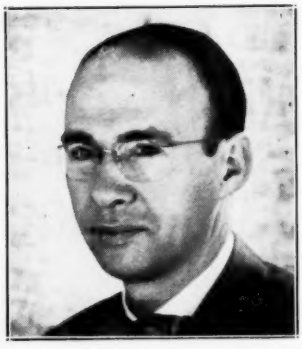
Mr Hackett has been with Solvay since 1923. In his new post he heads the engineering, research and construction departments. He will continue to make his headquarters at Solvay's Syracuse office.

ROBERT W WORK and RUSSELL O DENYES have been promoted to new positions with Celanese Corporation of America.

Dr Work, formerly assistant manager in charge of Textile Division process research at the Summit (N J) laboratories, was named assistant manager of plant operations for the Textile Division.

Dr Denyes, former head of viscose and new fiber research at Summit, succeeds to the post vacated by Dr Work.

F G Merckel



R M Jackson

G D Peet

FOLLOWING the merger of Wallace & Tiernan Co Inc and Novadel-Agene Corporation to form Wallace & Tiernan Incorporated, it was announced that F G MERCKEL has been elected president, R M JACKSON, executive vice president and treasurer and G D PEET, vice president in charge of product engineering and development.

Mr Merckel has been with the Wallace & Tiernan group in various executive and sales capacities for nearly thirty-five years. For the past two years he has been president of W C Hardesty Co Inc, a Wallace & Tiernan subsidiary.

Mr Jackson has been associated with the organization for over twenty years. He has been treasurer for the past several years and in that capacity has been active in overall management.

Mr Peet has been with Wallace & Tiernan almost since its inception. He has been chief engineer as well as an officer of subsidiary companies.

Responsible to Mr Merckel in staff capacities will be: H C MARKS, director of laboratory research; DAVID CRAMPTON, chief chemical engineer, J C CORNWALL, secretary of the Corporation; and T T QUIGLEY, assistant to the president and operational analyst.

It was also announced that WM J ORCHARD, long time general manager of Wallace & Tiernan and vice president of Novadel, who reached his 65th birthday in December, will remain on the Board of Wallace & Tiernan but will retire from active management.

ALFRED T LOEFFLER has been appointed vice president — Chemical Divisions of Food Machinery and Chemical Corporation. Mr Loeffler joined FMC as assistant vice president in August 1953. In his new position he will report to Ernest Hart, executive vice president, and will continue to be located at FMC's New York Office, 161 East 42nd Street.

Mr Loeffler began his career with Hooker Electrochemical Company. Subsequently, he served with Monsanto Chemical Company in various capacities including General Branch Manager in New York and Director of Development Organic Chemicals Division at St Louis. In 1951, on leave from Monsanto, he became chief, Chemical Branch Office of Price Stabilization in Washington.

STANLEY I CLARK (Sterling Drug Inc), Chairman of the Drug, Chemical and Allied Trades Section of the New York Board of Trade (DCAT) has announced the following list of chairmen to head committees for the current fiscal year: *Auditing*—W BOYD O'CONNOR, Ayerst, McKenna & Harrison, Ltd; *Bulletin*—F M SCHWEMMER, Ruthrauff & Ryan, Inc; *Co-ordination* (Program for unification of drug laws)—WILLIAM W HUISKING, Chas L Huisking & Co, Inc; *Finance*—HUGH S CROSSON, McKesson & Robbins, Inc; *Legislative*—JAMES G FLANAGAN, S B Penick & Co; *Luncheon Greetings* — RALPH A CLARK, J T Baker Chemical Co, (DONALD S CUSHMAN, Vice Chairman); *Membership*—S N STOKES, Merck & Co, Inc; DUDLEY DUNLOP, Mallinckrodt Chemical Works, Vice Chairman; *Membership Maintenance* —J DAVID HAYDEN, R P Scherer Corp; STEPHEN F URBAN, E R Squibb & Sons, Vice Chairman; *Publicity*—GEORGE S McMILLAN, Bristol-Myers Co; *Section Activities*—CLAUDE A HANFORD, Pharmaco, Inc; *Tariff*—FRED G SINGER, E I duPont de Nemours & Co, Inc; *Time and Place of 1955 Annual Meeting*—HAROLD F CUMMINGS, Vitamerican Oil Corp; *Trade Association Activities Coordinator*— L I VOLCKENING, The Ivers-Lee Co.

ell as an

in staff
, director
CRAMP-
eer, J C
Corpora-
sistant to
analyst.
WM J
manager
president
5th birth-
on the
but will

been ap-
Chemical
nd Chem-
ined FMC
gust 1953.
report to
dent, and
MC's New
et.
eer with
ny. Sub-
Monsanto
capacities
nager in
elopment
St Louis.
santo, he
Office of
on.

ng Drug
Chemical
the New
has an-
irmen to
ent fiscal
ONNOR,
d; *Bulle-*
hrauff &
gram for
LIAM W
Co, Inc;
McKesson
AMES G
Luncheon
RK, J T
S CUSH-
ership—$
DUDLEY
l Works,
intenance
rer Corp;
quibb &
GEORGE
; *Section*
RD, Phar-
GER, E I
Time and
—HAR-
ican Oil
ities Co-
NG. The